T14030

MODEL 6144

Universal EPUT® & Timer

(Prefix 500)

Beckman

Operating and Servicing Manual

GENERAL ELECTRIC CO.
Instrumentation & Control
328 W. Florence Ave.
Inglewood, Calif. 90301

Electronic Instruments Division

MODEL 6144

Universal EPUT® & Timer

(Prefix 500)

Beckman®
INSTRUMENTS, INC.
ELECTRONIC INSTRUMENTS DIVISION
RICHMOND, CALIFORNIA • 94804

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6144 Unit Logic Schematic
6144 Count Logic Schematic
Power Supply Schematic

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Data Storage Unit (DSU) Instruction Manual

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SECTION 1

INTRODUCTION

1.1 GENERAL

The solid-state Beckman Model 6144 is a multipurpose 2.5 mc counter and timer designed to measure frequency, period, time interval, and frequency ratio. This versatility is complemented by an easy-to-read electroluminescent display panel, which provides a seven digit reading, and displays the correct unit of measurement and the appropriate decimal point.

Special features incorporated in the Model 6144 extend the flexibility of the instrument and increase its usability. For example, the MULTIPLE PERIOD setting of the MODE selector allows the operator to time and average as many as 10^6 periods, thus increasing the accuracy of period measurement.

LATCH and FOLLOW positions of the POWER switch provide another feature. In LATCH, there is a continuous EL display during a count interval, but in FOLLOW the EL display is continuously updated in its presentation during a count interval.

A TEST feature enables the operator to check the instrument for proper operation. See paragraph 2.5.

1.2 SPECIFICATIONS

Specifications for the Model 6144 are given in Table 1-1.

Table 1-1

Input Frequency Range	
Frequency Measurement	dc to 2.5 megacycles
Interval Measurement	Period: 1.0 microsecond to 10^7 seconds with 1.0 microsecond resolution (dc to 1 mc)

	Multiple periods: 3.3 microseconds (dc to 300kc)
Input Resistance	INPUT's X and Y: 1 megohm shunted by 40 pf. AC coupling uses a .02 μf, 600V capacitor in series.
Input Sensitivity	INPUT's X and Y: 0.1 volt rms (0.3 volt peak-to-peak)
Maximum Input Voltage	INPUT's X and Y: DC: ±50 volts dc on 1 ATTEN FACTOR, ±600 volts dc on 10 and 100 ATTEN FACTOR AC: 50 volts rms on 1 ATTEN FACTOR, 600 volts peak (dc + ac) on 10 and 100 ATTEN FACTOR
Input Attenuation	1, 10, 100
Trigger Voltage Range	±1 volt, ±10 volts, and ±100 volts on 1, 10, and 100 ATTEN FACTORS respectively.
Resolution	
Gating	Better than 0.4 microseconds
Counting	Better than 0.4 microseconds
Oscillator Stability	3 parts in 10^7 per week with ±10% line variation and ±10 degrees C temperature variation

Accuracy Gating Period	 ±1 count ± time base crystal accuracy. Sine wave single period measurement accuracy is 0.3% at 1 volt rms input, and sine wave noise content 40 db down.
Multiple Period	±0.3% trigger error divided by periods averaged.
Time Base	1μsec. to 10 seconds in decade steps as selected by the TIME selector.
Recycle Rate	Continuously variable from 0.1 cps to 7 cps.
Visual Readout	Seven electroluminescent digits with automatically selected decimal points and unit nomenclature (KC, MC, μSEC, mSEC, and SEC).
Electrical Readout	Four-line 1-2-4-8 binary coded decimal Binary 0: -10 volts with respect to ground. Binary 1: Ground potential or slightly negative.
Operating Temperature Range	-20°C to +65°C
Storage Temperature	-55°C to +75°C
Power Requirements	117v ac, 50/60 cps, 100 watts
Dimensions	5-1/4" high, 16-3/4" wide, 19" deep
Weight	40 pounds

1.3 APPLICATIONS

Many laboratory, field test, and production line requirements are satisfied with the versatile Model 6144.

Laboratory uses might include frequency and stability checks on circuits under design, period measurements of low frequency waveforms where long term stability is essential, use as a secondary frequency standard, or calibrating less accurate frequency monitoring equipment.

The remote programming feature of this instrument makes it extremely useful for field test applications in integrated systems. An example would be in a military missile check-out system where a computer would remotely program the Model 6144 to measure period, frequency, ratio, etc., of the various electronic circuits in a missile guidance system.

Various transducers such as photocells, magnetic pickups and switches are useful in translating physical phenomena into voltage changes. With appropriate transducers, this instrument measures characteristics of such events relative to time. A few of the many applications are:

Frequency measurements	Tachometry
Frequency ratio measurements	Telemetry
Relay and switch timing	Pulse height analysis
Phase measurements	Oscilloscope time base calibration
Ballistic measurements	Secondary frequency standard

1.4 ACCESSORIES

The Model 1453 Printer, designed for use with this instrument, converts count information into a printed record on a standard adding machine tape. This printer is ideal for making long term stability checks, recording voltage changes, or making a permanent printed record in control or measuring systems.

Beckman Model 651 Voltage-to-Frequency Converter plug-in indirectly allows the Model 6144 to measure dc voltages from 0.1 volts to 1000 volts. Other plug-ins are being developed for use with this counter.

A Beckman Digital to Analog Converter converts the count accumulated during each counting period to a representative voltage level. This voltage level is retained until a new count is made, at which time the converter changes its voltage level to conform to the new count. The changing levels can control the operation being monitored, or when applied across a self-balancing potentiometer, drive a pen recorder for an analog record.

SECTION 2

OPERATION

2.1 GENERAL

The Model 6144 has two input circuits, a time base generator, a signal gate, a chain of decimal counting units, and Data Storage Units with an EL display. The input circuits (INPUT's X and Y) produce output pulses representative of the voltage change at their inputs. These pulses can be used as start, stop, or count signals. The time base generator produces clock pulses (selected by TIME selector) which also are used as start, stop or count signals. Depending on the mode (E/UT X, TIM X-Y, etc.) selected by the MODE selector, the three pulse sources supply start signals to open the gate, stop signals to close the gate, and count signals which pass through the gate to be counted by the DCU's. The count accumulated by the DCU's is transferred to the Data Storage Units (DSU's), and then displayed on the EL panel.

In E/UT X, for example, the INPUT X circuit provides count signals, while the clock pulse generator provides start and stop signals. See Section 2.6 for specific information on the individual modes of operation.

2.2 APPLYING POWER

The instrument is ready for use as it arrives from the factory. Connect the power cord to a 117v ac, 50-60 cps, outlet. The crystal oven and oscillator circuits energize immediately, and the instrument is ready for operation. After about 72 hours of operation, the oscillator will meet its stability specification. Therefore, if the instrument is used intermittently, leave the power cord connected at all times to avoid waiting for crystal warm-up.

NOTE

> Do not remove the Model 696 Basic Plug-in unless other plug-ins are used. Each plug-in completes certain circuits in the instrument that are essential for operation.

2.3 TYPES OF MEASUREMENT

The Model 6144 makes three basic measurements in addition to manually gated counting.

1) It counts the number of events occurring during a precise time interval. This is E/UT operation. Frequency measurements are made in this mode.

2) It measures the time interval between two events. For Time Interval Measurement (TIM) the two events occur on separate input channels. For PERIOD measurements the two events occur on the same input channel. If the interval at the same input is multiplied by some factor (10, 10^2, etc.), thus extending the counting period, the operation is known as MULTIPLE PERIOD.

3) It counts the number of events at one input during the interval between consecutive events at the other input. This mode of operation is known as Ratio (more specifically, frequency ratios). Ratio measurements are made in two ways: (a) UNITS Y/PERIOD X, (b) UNITS Y/MULTIPLE PERIOD X.

2.4 OPERATING CONTROLS AND CONNECTORS

Operating controls and connectors are described in Table 2-1.

Table 2-1

Name	Function
POWER Switch	Turns power on when turned to LATCH or FOLLOW.
FOLLOW Position	Part of POWER switch. Causes EL reading to continually update its presentation during count interval, and then hold reading into next count interval.

Table 2-1 (continued)

Name	Function
LATCH Position	Part of POWER switch. Readout displays the total count of each counting interval and holds it without change until there is a new total count.
TIME Selector	Selects Gate Time for E/UT and TEST measurements. Also selects TIME Units in which measurement appears for 1 PERIOD X, MULTIPLE PERIOD X, and TIM X-Y. Selects INPUT Y Circuit for ratio measurement.
MODE Selector	Interconnects logic blocks to perform the measurement indicated.
ATTEN FACTOR Control	Attenuates the signal and dc level at the input jack by the factor to which the control is set. Selects ac or dc input coupling to the attenuator.
TRIGGER Control	Selects the instantaneous voltage at which the input signal causes the input trigger circuit to generate an output pulse.
SLOPE Switches	Determine which slope (positive or negative) of the input signal will start or stop the counting action.

Table 2-1 (continued)

Name	Function
RECYCLE RATE Control	Controls the rate at which the instrument will sample new data. In MAX position, counter recycles at a maximum rate. Set to MAN, instrument recycle is manually controlled by pressing RESET pushbutton.
Manual RESET Pushbutton	With latched indication the RESET control performs either of two functions dependent upon whether the Count Gate is closed or open. 1) Closed - accumulated data is transferred to the DSU's and presented on the EL display and a new count accumulated. 2) Open - instrument is reset to zero and a new count accumulated. Stored data is retained. With FOLLOW indication the RESET control causes instrument to reset to zero and accumulate a new count.
INPUT Jacks	For signal inputs to INPUT's X and Y.
GATE OPEN Light	Light is on when count gate is open. Provides additional visual indication of counter recycle.

NOTE

See Auxiliary Connectors, Section 2.9, for information on connectors used in special variations of the standard operating procedure.

2.5 TESTING FOR PROPER OPERATION

The self-checking procedure is simple, quick, and may be performed each time the instrument is energized.

1) Set POWER switch to LATCH.

2) Turn RECYCLE RATE control fully clockwise to obtain a maximum recycle rate.

3) Turn MODE selector to TEST.

4) Turn TIME selector to each time position starting with 1 μsecond and continuing to 10 seconds. Correct count indications are shown in Table 2-2.

Table 2-2

TIME SELECTOR POSITION	CORRECT COUNT INDICATIONS		
1 μsec.	0000000	0000001	0000002
10 μsec.	0000009	0000010	0000011
0.1 msec.	0000099	0000100	0000101
1 msec.	0000999	0001000	0001001
10 msec.	0009999	0010000	0010001
0.1 sec.	0099999	0100000	0100001
1 sec.	0999999	1000000	1000001
10 sec.	9999999	0000000	0000001

5) If a correct count indication appears at all positions, the instrument is operating properly.

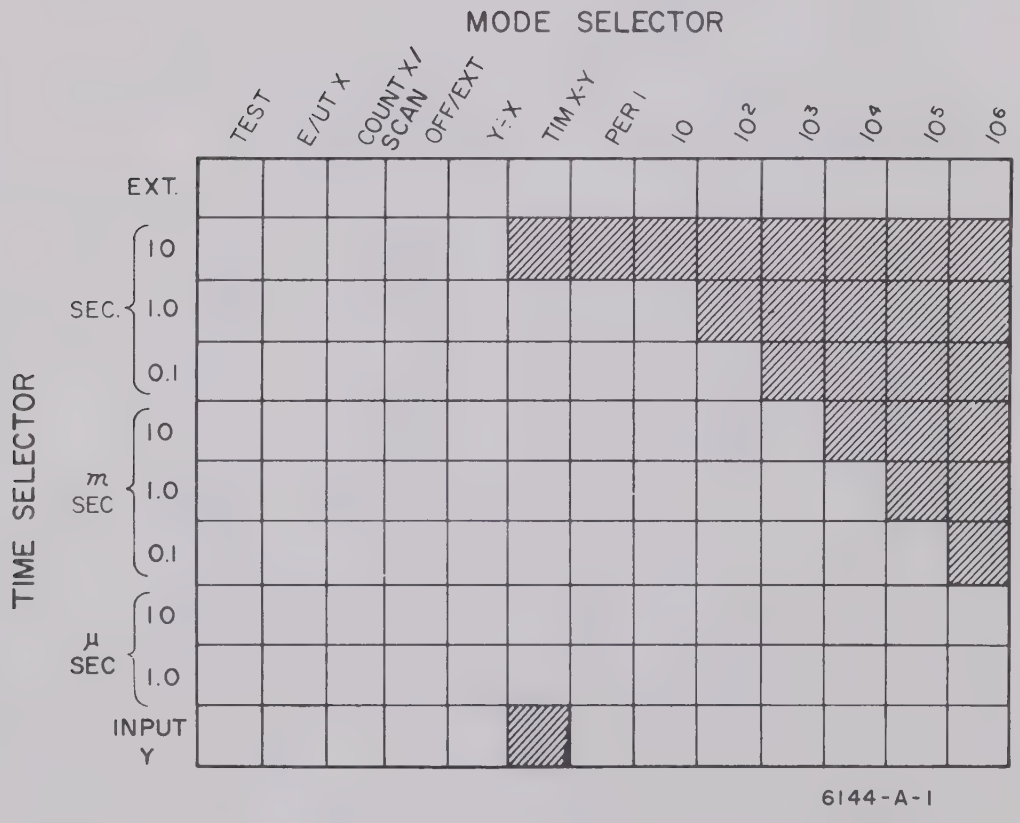
6) Instrument may be tested in FOLLOW to observe count change. Retard RECYCLE RATE control to approximately 1 reading per second for best observation.

2.5.1 EL Indicator Panel Check

To visually test the EL indicator panel, place the MODE selector in 10^6 MULTIPLE PERIOD X and the TIME selector in any position from 1.0 μseconds to 10 seconds. All eights will appear on the panel showing the 7-bar configuration of each of the 7 digits.

Any incompatible setting of the TIME and MODE selectors will cause all eights to appear on the EL panel. Table 2-3 shows the incompatible positions of the two controls.

Table 2-3



Indicates incompatible positions of the TIME and MODE Selectors (all eights appear on the readout)

As shown in Table 2-3, the TIM X-Y and 1 PERIOD X modes are made incompatible with a 10 second time base. The long time duration needed between start and stop pulses, to allow enough counts (1 count/10 seconds) to be accumulated by the DCU's, make these modes of operation impractical. For example, in order to count ten clock pulses from the time base, the start and stop pulses would have to be separated by 100 seconds.

Table 2-3 also shows that MULTIPLE PERIOD positions (10, 10^2, etc.) of the MODE selector are incompatible with certain positions of the TIME selector. To understand why some TIME and MODE selector positions are incompatible, it is first necessary to understand the operation of the DCU divider chain.

The DCU divider chain serves as time base dividers, or as dividers for MULTIPLE PERIOD operation. Each DCU in the divider chain performs one function, i.e., to divide its input by 10. The DCU cannot simultaneously divide clock pulses, and also divide a series of pulses from the INPUT X circuit in some MULTIPLE PERIOD position. Therefore, the DCU can only be used for one function at a time.

Thus, incompatible positions occur when the same DCU is selected for simultaneous use as a time base divider and as a divider for MULTIPLE PERIOD operation.

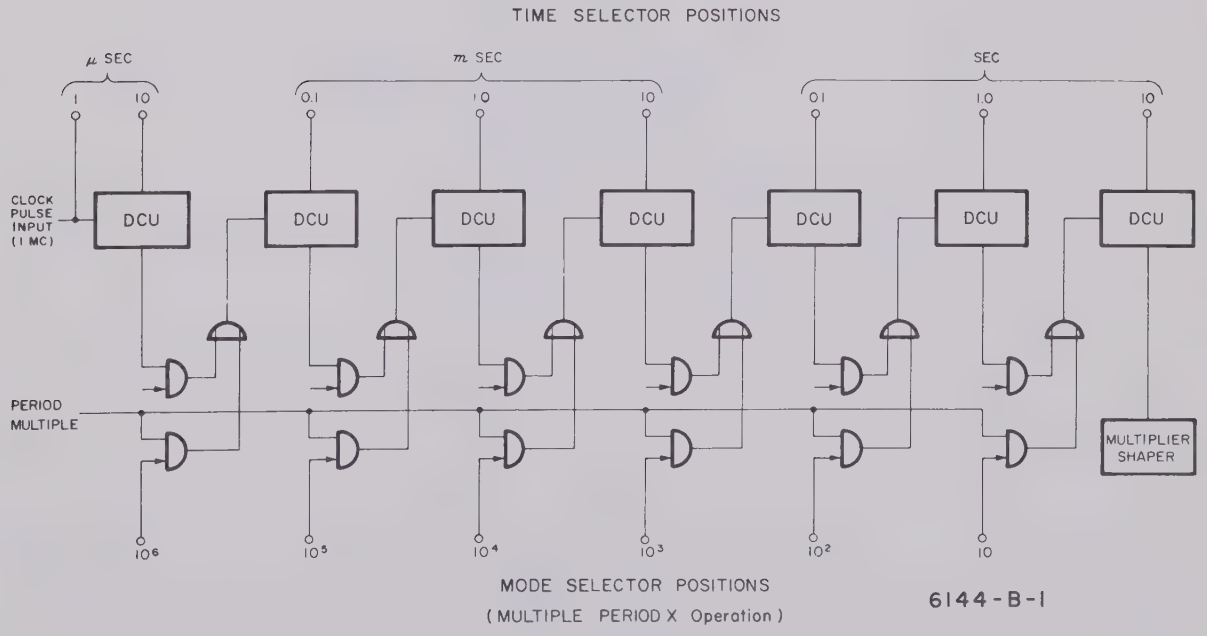


FIG. 2-1. Simplified Block Diagram of DCU Divider Chain.

For example, setting the TIME selector to 1 mSEC and the MODE selector to 10^5 PERIOD X causes the same DCU to perform two functions. This results in an incompatible position. Figure 2-1 shows the logic of the DCU divider chain.

With the TIME selector in UNITS Y and the MODE selector in TIM X-Y, eights appear in the readout. Input Y provides the pulse to close the count gate; therefore, any pulse that could be counted would also close the gate.

2.6 MODES OF OPERATION

Refer to Table 2-4.

Table 2-4

Modes of operation	What the instrument does in each mode
TEST	Counts 1.0 mc oscillator output during each timing interval.
E/UT X	Counts events at INPUT X during a time unit selectable between 1μsecond and 10 seconds by TIME selector (frequency measurement).
COUNT X/SCAN	SCAN: Counts events at INPUT X during manually controlled multiples of the time base. COUNT X: Counts events at INPUT X during manually controlled counting period.
OFF	For manual control of COUNT X.
Y ÷ X	Measures ratio of INPUT Y frequency to INPUT X frequency (number of events at INPUT Y during one event at INPUT X).

Table 2-4 (continued)

Modes of operation	What the instrument does in each mode
TIM X-Y	Time Interval Measurement - Measures the interval between an event at INPUT X and an independent event at INPUT Y. Time units (1 μsec. to 1 sec.) selected by TIME selector.
PERIOD X	1 PERIOD X: Measures the time interval between consecutive events at INPUT X. Time units (1 μsec. to 1 sec.) selected by TIME selector. MULTIPLE PERIOD X: Measures the time interval between multiple events (10, 10^2, . . . 10^6) at INPUT X.
Ratio	UNITS Y/1 PERIOD X: TIME selector set to UNITS Y, and MODE selector to 1 PERIOD X. Measures ratio of INPUT Y frequency to INPUT X frequency (number of events at INPUT Y during one event at INPUT X). UNITS Y/MULTIPLE PERIOD X: TIME selector set to UNITS Y, and MODE selector to one of the MULTIPLE PERIOD positions (10, 10^2, . . . 10^6). Measures ratio of INPUT Y frequency to multiples of INPUT X frequency.

2.6.1 E/UT X MODE

With the MODE selector in E/UT X, the instrument counts events at INPUT X during unit of time selectable between 1 μsecond and 10 seconds (frequency measurements). The functional blocks connect as shown in Figure 2-2.

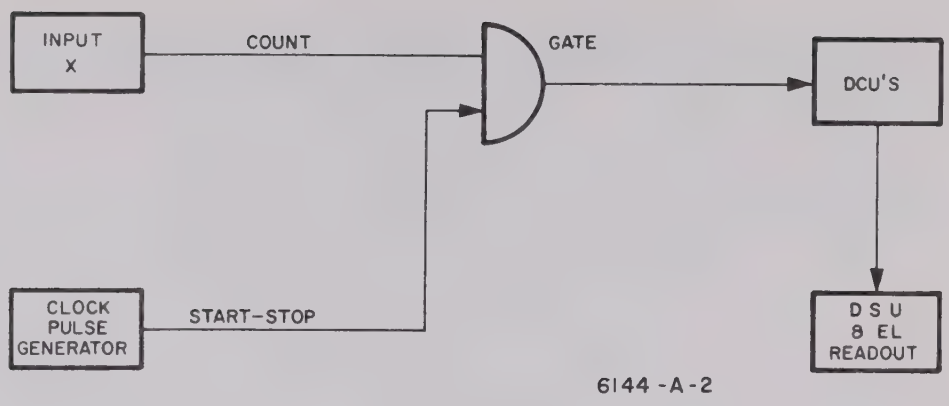


FIG. 2-2. E/UT X MODE.

Operating Procedure

1) Connect the input signal to the INPUT X. Adjust the ATTEN control as described in Section 2.7.7.

2) Turn the MODE selector to E/UT X.

3) Set the TIME selector to the time interval over which events are to be counted. A longer time base will increase the number of digits displayed. thus increasing measurement accuracy.

4) Adjust RECYCLE RATE control for a convenient reading or recording rate.

5) The readout displays count. units, and decimal point

2.6.2 SCAN

Counts events at INPUT X during manually controlled multiples of the time base setting. The SCAN function provides a method of measuring low frequencies accurately without resorting to period measurement. The functional blocks connect as shown in Figure 2-3.

1) Connect the input signal to INPUT X. Adjust ATTEN control as described in Section 2.7.7.

2) Switch RECYCLE RATE control to MAN.

3) Turn MODE selector to E/UT X.

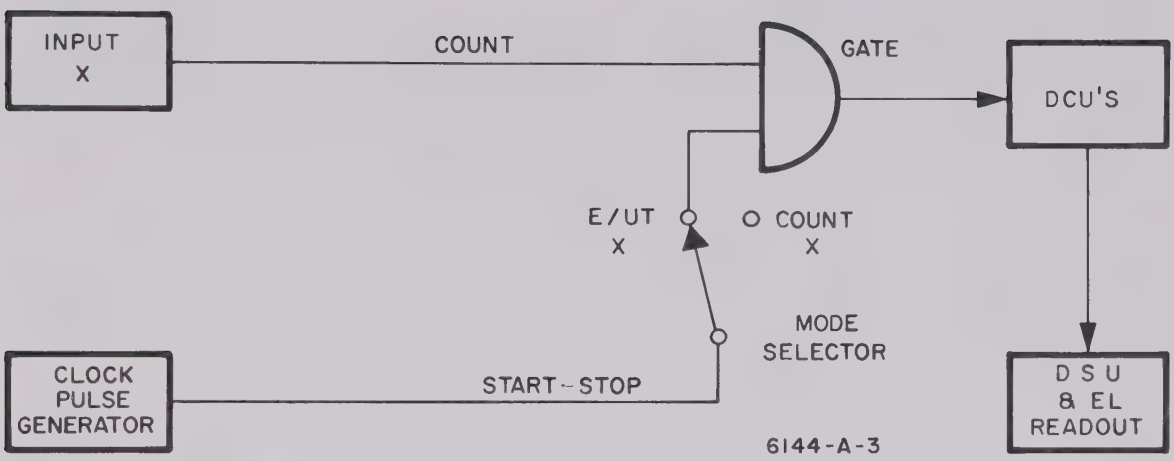


FIG. 2-3. SCAN

4) Turn TIME selector to 10 SEC.

5) Turn POWER switch to either LATCH or FOLLOW.

6) Press the RESET pushbutton to start the counting action, and begin timing the desired number of period measurements. With TIME selector in 10 SEC, each timing period is 10 seconds.

7) Quickly turn MODE selector to COUNT X. Continue timing the periods.

8) Approximately half-way through the last timing period, turn the MODE selector back to E/UT X. Counting will stop with the next stop pulse.

9) Count remains on EL display until instrument is manually recycled.

10) To obtain the input frequency in events per second, divide the count indication by the total counting interval in seconds. Example: If the count displayed is 10,000 and the number of timing periods is 100 (10 seconds times 10 periods = 100), the input frequency in events per seconds is 100

11) To start a new measurement, repeat steps 6, 7, 8, and 9.

2.6.2 COUNT X MODE

With the MODE selector at COUNT X, the instrument counts events at INPUT X during manually controlled counting period. The functional blocks connect as shown in Figure 2-4.

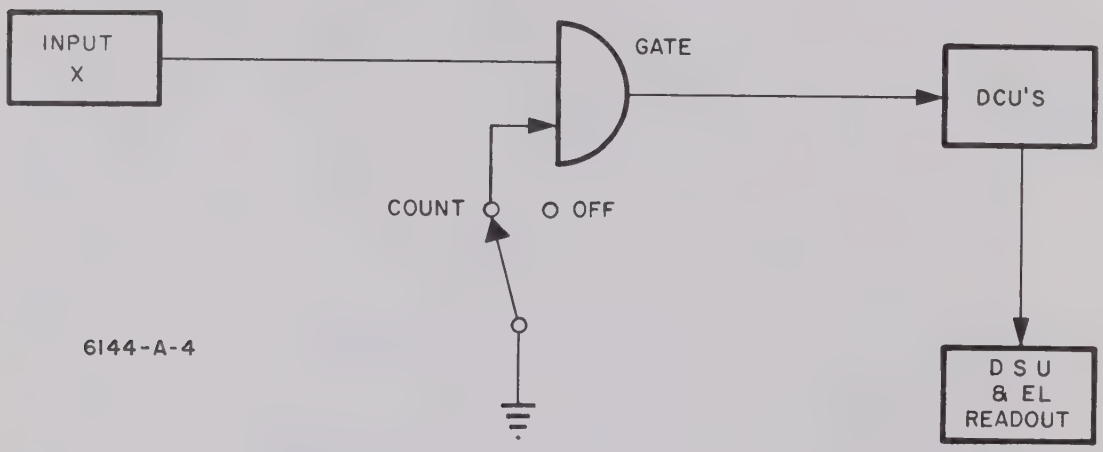


FIG. 2-4. COUNT X MODE.

Operating Procedure

1) Connect input signal to the INPUT X jack. Adjust the ATTEN control as described in Section 2.7.7.

2) Turn MODE selector to OFF.

3) Press manual RESET button. This resets counter to zero.

4) Turn MODE selector to COUNT. This begins the counting action. The input channel will trigger only on the negative slope of the input waveform.

5) Turn MODE selector to OFF to stop the counting. The GATE OPEN light will stay on continuously in this mode of operation.

6) Read the count indication. To continue counting without erasing the previous indication, turn MODE selector back to COUNT.

2.6.4 TIM X-Y MODE

With the MODE selector in TIM X-Y, the instrument measures the interval between an event at INPUT X and an independent event at INPUT Y. The functional blocks connect as shown in Figure 2-5.

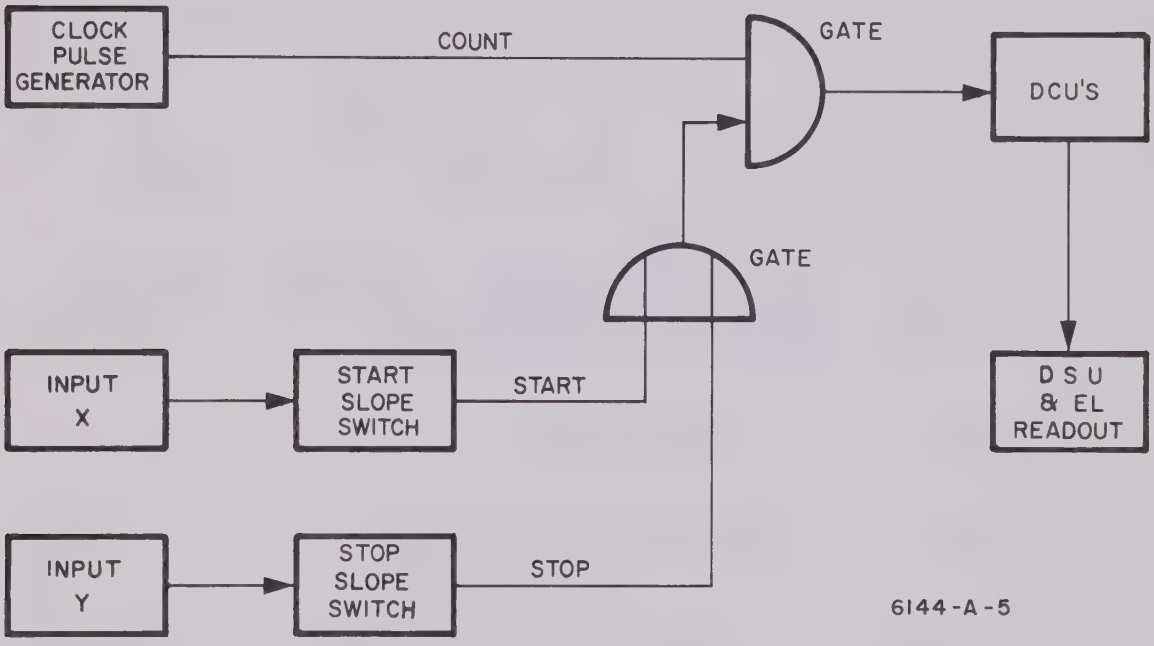


FIG. 2-5. TIM X-Y MODE.

Operating Procedure

1) Connect the stop signal to INPUT Y. Adjust INPUT Y TRIGGER control as described in Section 2.7.8.

2) Connect the start signal to INPUT X. Adjust INPUT X TRIGGER control as described in Section 2.7.7.

3) Turn MODE selector to TIM X-Y.

4) The START and STOP SLOPE switches select the polarity of the voltage excursion that starts and stops the counting period, respectively.

5) Set the TIME selector to the desired unit of time measurement. For example, at the 1 mSEC position the time measurement appears with one millisecond resolution. The smaller the time unit chosen, the greater the resolution.

6) Adjust the RECYCLE RATE control for a convenient reading or recording rate.

7) The readout automatically displays count, units, and decimal point.

2.6.5 PERIOD Measurement

2.6.5.1 PERIOD X MODE

With the MODE selector in 1 PERIOD X, the instrument measures the interval between consecutive events at INPUT X. This mode measures the period of a cyclical waveform, the width of a pulse, or separation of pulses. The functional blocks connect as shown in Figure 2-6.

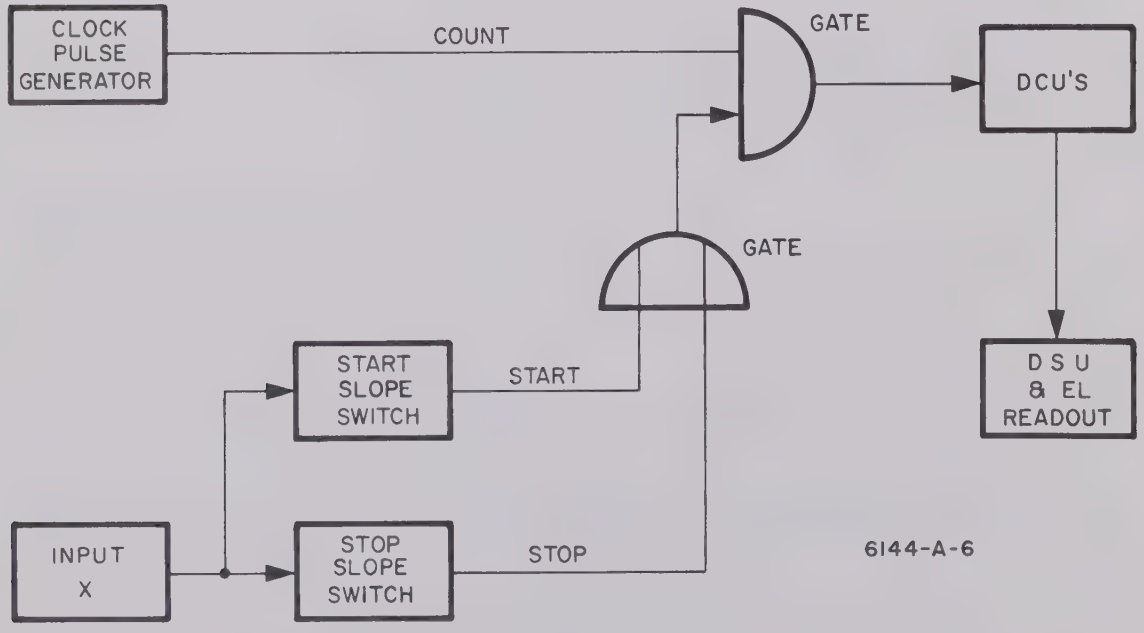


FIG. 2-6. PERIOD X MODE.

Operation Procedure

1) Connect input signal to INPUT X. Adjust the ATTEN control as described in Section 2.7.6. An oscilloscope may be required to position trigger points on asymmetrical waveforms. A SCOPE jack on the rear panel provides an output representing the Count Gate. Triggering the oscilloscope at the opening or closing of the Count Gate while monitoring the input waveform, permits the operator to see the start or stop points on the input waveform.

2) Turn MODE selector to 1 PERIOD X.

3) The START SLOPE switch selects the polarity of the voltage excursion that starts the timing period; the STOP SLOPE switch selects the polarity of the excurstion that stops timing. Therefore,

   a) To measure the period of a cyclical waveform, set both SLOPE switches to "+" or both to "-".

   b) To measure the width of a positive waveform, set the START SLOPE switch to "+" and the STOP SLOPE switch to "-".

   c) To measure the width of a negative waveform, set the START SLOPE switch to "-" and the STOP SLOPE switch to "+".

   d) To measure positive pulse separation, set the START SLOPE switch to "-" and the STOP SLOPE switch to "+", or vice versa for negative pulses.

4) Switch the TIME selector to the desired unit of time measurements. For example, at the 1 mSEC position the time measurement appears with one millisecond resolution. The smaller the time unit chosen, the more accurate the reading within limits of period accuracy.

5) Adjust the RECYCLE RATE control for a convenient reading or recording rate.

6) Readout automatically displays count, units, and decimal point.

2.6.5.2 MULTIPLE PERIOD X MODE

With the MODE selector at one of the MULTIPLE PERIOD positions (10, 10^2, . . . 10^6), the instrument measures the interval between multiple events at INPUT X. These settings will measure the period of an event more accurately than 1 PERIOD X by averaging a greater number of periods over which counting occurs. The functional blocks connect as shown in Figure 2-7.

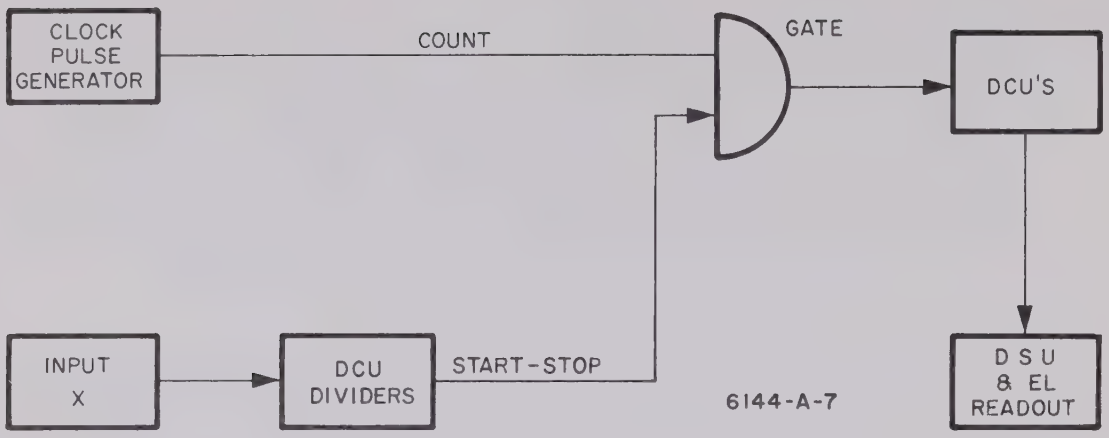


FIG. 2-7. MULTIPLE PERIOD X MODE.

Operating Procedure

1) The INPUT X TRIGGER adjustment is made the same as in 1 PERIOD X. The maximum frequency that can be used in MULTIPLE PERIOD X is 300 kc as limited by the DCU dividers.

2) Select a position (10, 10^2, . . . 10^6) on the MODE selector. The larger the number, the greater the number of periods over which counting will be averaged.

3) Set the TIME selector to desired unit of time measurement. The smaller the time unit chosen, the greater the resolution.

NOTE

There are certain positions of the TIME and MODE selectors that are incompatible. See Table 2-2.

4) INPUT X triggers only on the negative slope of the input waveform.

5) Adjust the RECYCLE RATE control for a convenient reading or recording rate.

6) Readout automatically displays count, units and decimal point.

2.6.6 Ratio Measurements

2.6.6.1 UNITS Y/PERIOD X MODE

With the MODE selector in 1 PERIOD X and TIME selector in UNITS Y, the instrument measures ratio of INPUT Y frequency to INPUT X frequency (number of events at INPUT Y during one event at INPUT X). Functional blocks connect as shown in Figure 2-8.

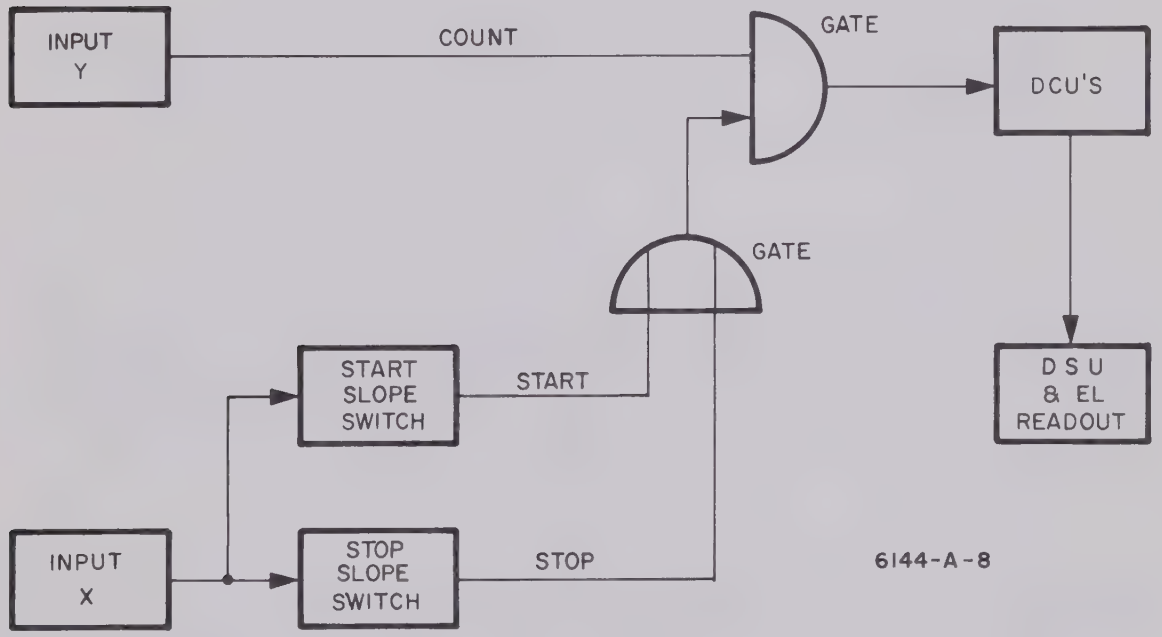


FIG. 2-8. UNITS Y/PERIOD X MODE.

Operating Procedure

1) Connect the higher frequency to the INPUT Y. Adjust INPUT Y ATTEN control as described in Section 2.7.8.

2) Connect the lower frequency to the INPUT X. Adjust INPUT X ATTEN control as described in Section 2.7.7.

3) Switch MODE selector to 1 PERIOD X, and the TIME selector to UNITS Y.

4) The START SLOPE switch determines the polarity of the voltage excursion that starts the counting period. The STOP SLOPE switch sets the polarity of the voltage excursion that stops the counting period. Therefore,

   a) When measuring the ratio of two frequencies set both SLOPE switches to "+" or both to "-".

   b) When counting the INPUT Y during the period that INPUT X voltage remains below a certain negative level, set the START SLOPE switch to "-" and the STOP SLOPE switch to "+".

5) The INPUT Y triggers on a negative-going input.

6) Adjust the RECYCLE RATE control for a convenient reading or recording rate

7) The readout automatically displays count information.

2.6.6.2 UNITS Y/MULTIPLE PERIOD X

With the MODE selector in one of the MULTIPLE PERIOD X positions and the TIME selector in UNITS Y, the instrument measures ratio of INPUT Y to multiple events at INPUT X. Ratio measurements are more accurate using multiple periods because a greater number of periods are averaged over which INPUT Y is counted. Functional blocks connect as shown in Figure 2-9.

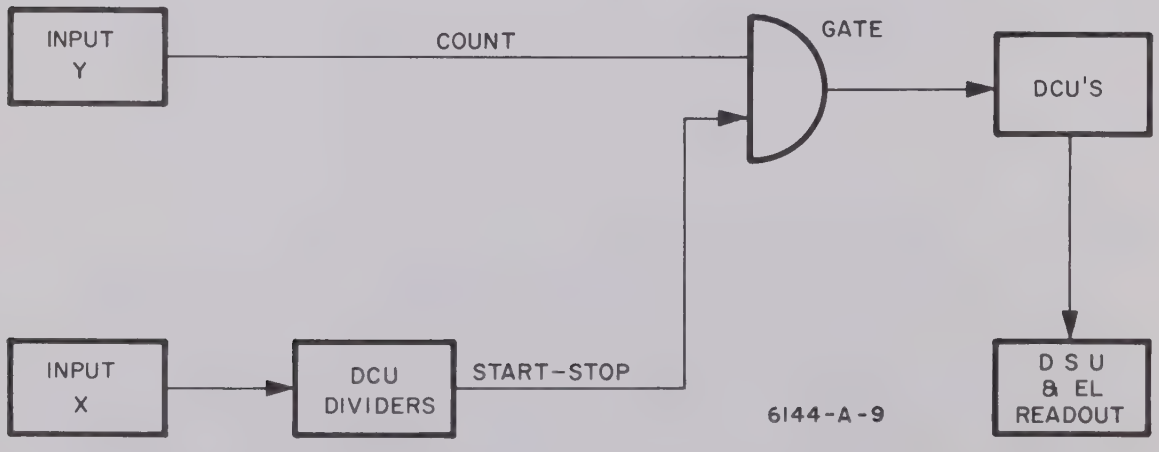


FIG. 2-9. UNITS Y/MULTIPLE PERIOD X.

Operating Procedure

1) Set up the input channels as in UNITS Y/1 PERIOD X.

2) Turn MODE selector to some position of MULTIPLE PERIOD X (10, 10^2, . . . 10^3, etc.). The number of periods selected determines the number of events required at INPUT X to start and stop counting. Counting starts and stops on the negative-going slope of the INPUT X signal for periods of 10 through 10^6.

3) Switch TIME selector to UNITS Y. The INPUT Y channel triggers on the negative-going input signal.

4) Adjust RECYCLE RATE for a convenient reading or recording rate.

5) The readout displays count information and automatically places the decimal.

2.6.6 Y ÷ X MODE

With MODE selector in Y ÷ X, the instrument measures ratio of INPUT Y frequency to INPUT X frequency (number of events at INPUT Y during one event at INPUT X). When used with the Transfer Oscillator, the TIME selector is used to select a desired frequency from the time base with output available at the rear panel.

2.7 INPUT'S X AND Y

Information in this section applies to both INPUT's X and Y, since these input circuits are identical. Figure 2-10 is a block diagram of one of these input circuits.

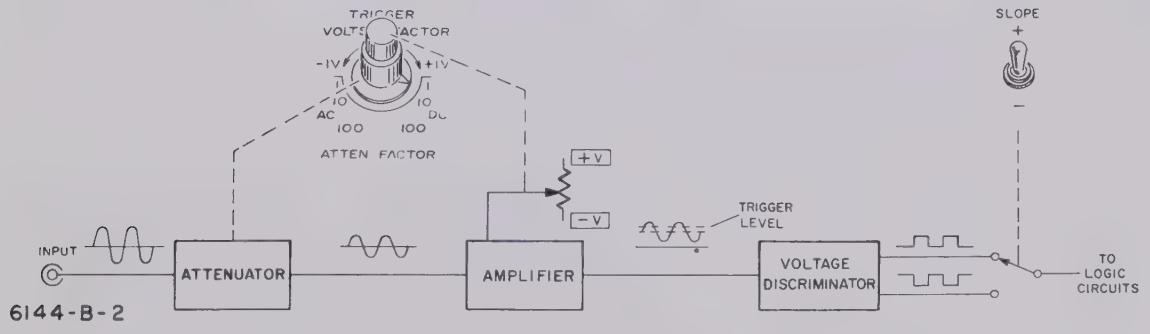


FIG. 2-10. Simplified Input Circuit Block Diagram.

2.7.1 ATTEN FACTOR Control

2.7.2 Input Coupling

The ATTEN FACTOR selector selects AC or DC coupling and input attenuation. In the DC position the dc (plus the ac component of the input signal) couples to the attenuator. Switching to AC places a .02 μf, 600 vdc capacitor between the input jack and the attenuator permitting only the ac component of the input to reach the attenuator. The equivalent input circuit is 1 megohm for all ATTEN FACTOR positions. The input circuit is shunted with approximately 40 pf at each attenuator position. A typical drift figure at the DC "1" position is 3 mv/°C.

2.7.3 Attenuation

Each position of the ATTEN FACTOR control divides the input signal by the factor indicated (1, 10, and 100). Effectiveness of the TRIGGER control depends on the correct use of the ATTEN FACTOR control. Since these two controls are interdependent, the use of the ATTEN FACTOR control is discussed with the TRIGGER control in Section 2.7.4.

2.7.4 The TRIGGER Control

As shown in Figure 2-10, the TRIGGER control is part of the amplifier, and determines the voltage at which an input signal causes the input circuits to generate an output pulse. The amplifier output signal drives a voltage discriminator circuit. The discriminator exhibits a characteristic known as hysteresis. Hysteresis is a small, fixed voltage range, centered around a fixed dc level at the discriminator's input. When a voltage change passes through this hysteresis range, the discriminator output changes voltage levels (Figure 2-11A). This voltage level remains until a voltage change again passes back through this hysteresis range, at which time the discriminator's output returns to its original state (Figure 2-11B).

The amplifier output is shifted by the TRIGGER control in either a positive or negative direction to allow the operator to choose a particular point on the waveform to trigger the discriminator circuit. As long as the amplitude of the voltage change is large enough to pass through the hysteresis range, triggering will occur.

For example, with the ATTEN FACTOR control in AC "1", the TRIGGER control adjustment range is ±1 volt; that is, it can shift a signal referenced at the input over a ±1 volt range at the discriminator's input. Using a 10 volt p-p input, the ±1 volt adjustment range is not adequate to shift the 10

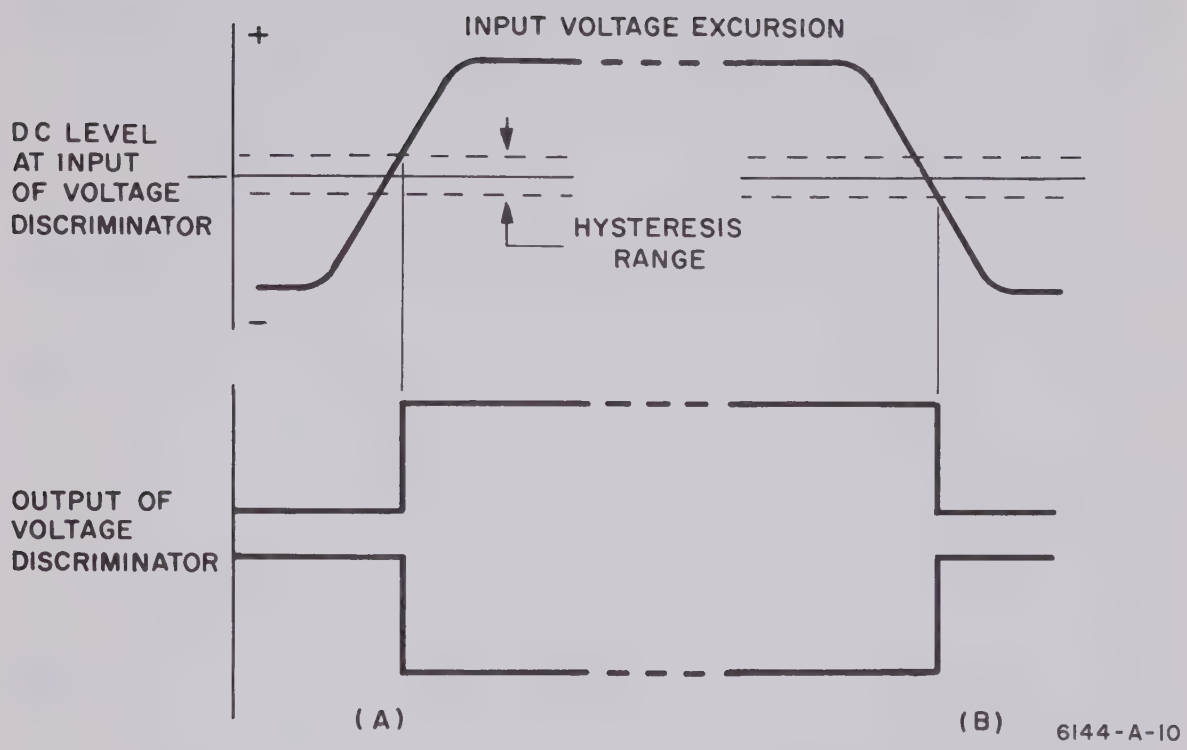


FIG. 2-11. Shows output of voltage discriminator as a voltage change passes through hysteresis range.

volt p-p signal enough in a positive or negative direction to permit any desired part of the signal to pass through the hysteresis range of the discriminator circuit (see Figure 2-12A). Therefore, the ATTEN FACTOR control becomes important. By setting the ATTEN FACTOR control to AC "10", the input signal driving the amplifier is attenuated by a factor of 10, thus the signal driving the amplifier is 1 volt p-p. A 1 volt p-p signal can be shifted enough so the desired part passes through the hysteresis range of the discriminator circuit (see Figure 2-12B).

The input signal is reduced to fall within the range of the TRIGGER control. Therefore, effective range of this control is multiplied by the setting of the ATTEN FACTOR (i.e., 10, 100).

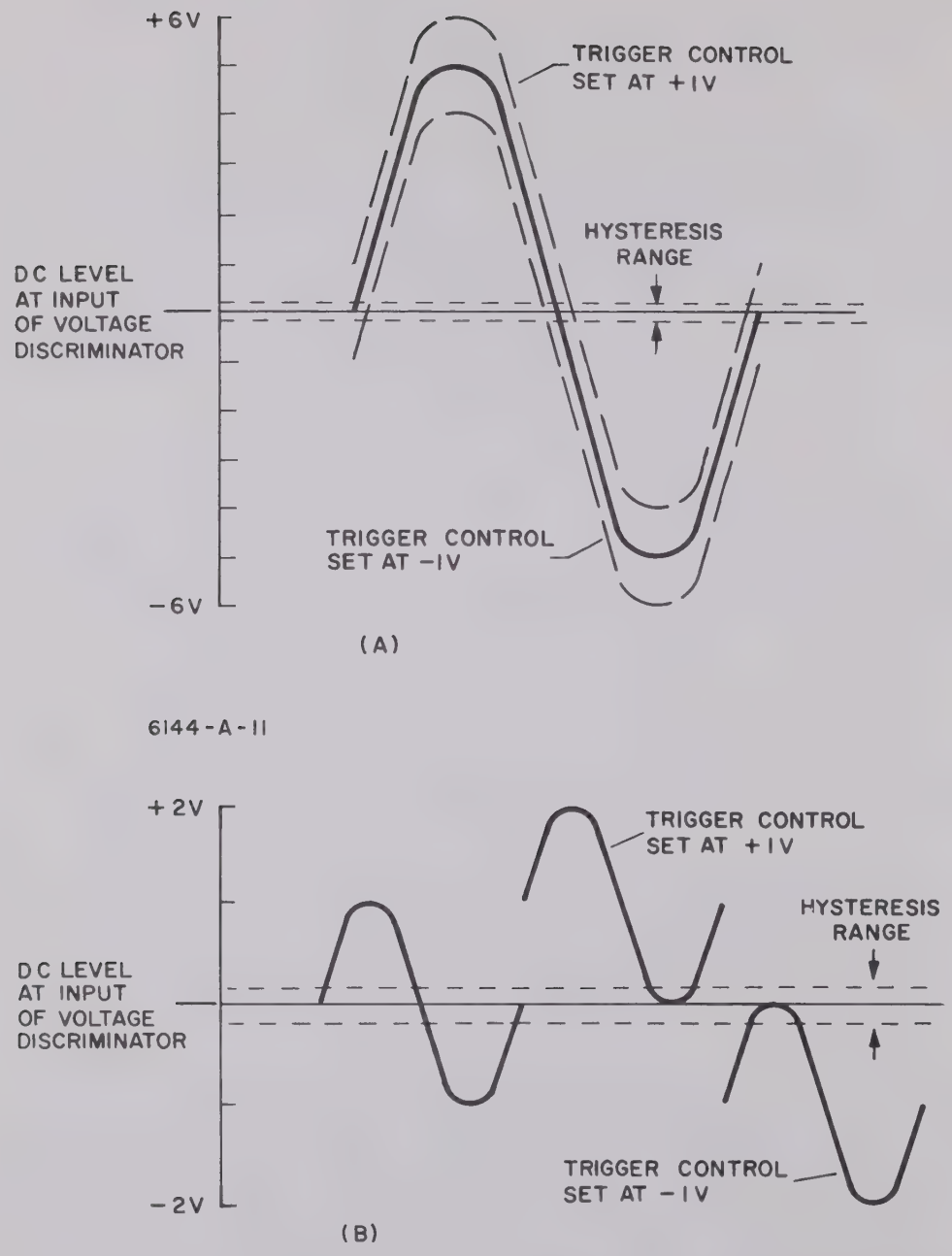


FIG. 2-12. (A) shows that the TRIGGER control range is not enough to shift any part of the input signal through the hysteresis range of the voltage discriminator; (B) shows the signal attenuated enough so it passes through this range.

For dc coupled signals, the dc level (plus the ac component) has to be considered in adjusting the ATTEN FACTOR and TRIGGER controls. If the dc level is large, the ac component may never be within range of the TRIGGER control; therefore, the ATTEN FACTOR control may have to be set to 10, or 100. However, since the ac component is also attenuated, it may then be less than minimum sensitivity of the discriminator circuit.

2.7.5 SLOPE Switches

The SLOPE switch determines which slope (positive or negative) of the input signal will start or stop the counting.

Figure 2-13 shows the input signal slopes in relation to the discriminator output pulse.

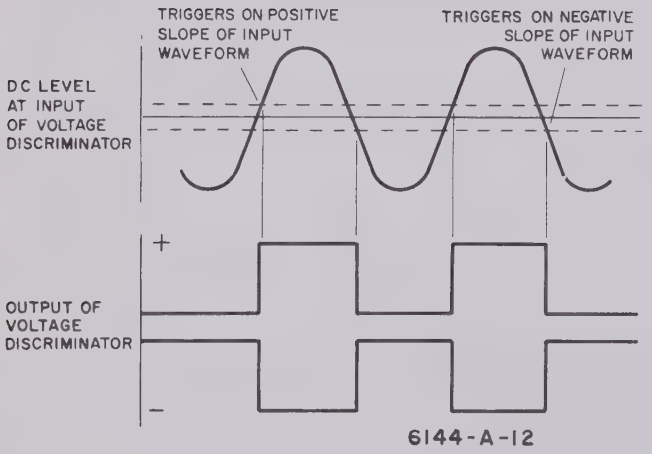

TRIGGERS ON POSITIVE SLOPE OF INPUT WAVEFORM
TRIGGERS ON NEGATIVE SLOPE OF INPUT WAVEFORM
DC LEVEL AT INPUT OF VOLTAGE DISCRIMINATOR
+
OUTPUT OF VOLTAGE DISCRIMINATOR
–
6144-A-12

FIG. 2-13.

Shows output of voltage discriminator with sine wave input; also relationship of input signal slope to voltage discriminator output.

Logic circuits in this instrument respond only to positive going slopes of the voltage discriminator output; therefore, it is possible to select the desired slope of the input signal to operate the instrument.

For example, the period of a sine wave can be determined by setting both SLOPE switches to "+" or "-". The positive slopes of the input waveform correspond to the "+" setting of the SLOPE switch and to the positive-going slope of the positive output pulse of the discriminator. The negative slopes of the input waveform correspond to the "-" setting of the SLOPE switch and to the positive-going slope of the negative output pulse of the discriminator.

2.7.6 Using the TRIGGER control

The purpose of the input trigger channel is to produce a reliable pulse output representing a selected part of the input signal. Proper adjustment of the ATTEN FACTOR and TRIGGER controls ensures this condition. Before adjusting the controls, try to visualize the input waveform, noting the ac amplitude and dc level. The effect of various control settings is as follows:

1) If the attenuated signal is small (p-p), the trigger voltage level may be set too high or too low to produce a pulse.

2) If the attenuated voltage variations "ride" on a dc level, they may not come within the trigger voltage range.

3) Modulation or other variation of the attenuated signal is least likely to cause trigger failure if the trigger voltages are set about halfway between the peaks of the signal.

4) Extraneous signals (noise or modulation) have the least effect on the time at which a pulse occurs when the input circuit triggers on a steep slope of the waveform.

5) Noise below the range of the trigger circuit will not trigger extraneous pulses. Consequently, attenuating a noisy signal may reduce the effect of the noise.

6) Attenuating the input signal:

   a) Reduces the slope at all points.

   b) Shifts the ac component nearer ground if it rides on a dc level.

   c) Increases the minimum p-p variations necessary to trigger the input circuit (measured at the INPUT).

   d) Increases the range of possible trigger voltage control over the input signal from ±1 volt to ±100 volts.

2.7.7 INPUT X TRIGGER Control Adjustment

1) Set ATTEN FACTOR control to 100.

2) Couple signal to INPUT X.

3) Switch MODE selector to COUNT X.

4) Slowly turn TRIGGER control between its extreme positions, and note whether counting occurs. If counting occurs, proceed to step 6; otherwise, continue on to step 5.

5) Repeat step 4, each time reducing the attenuation factor, i.e., 10, 1, until counting occurs. If no counting occurs in ATTEN "1", determine if an adequate input signal is present.

6) By turning the TRIGGER control, determine the positions which start and stop counting, then set the control midway between two positions. The INPUT X trigger circuit should now be operating properly.

7) Refer back to Mode of Operation section (Section 2.6) for further information on mode being used.

2.7.8 INPUT Y TRIGGER Control Adjustment

1) Make sure no signal is connected to INPUT X.

2) Switch MODE selector to PERIOD X.

3) Switch TIME selector to UNITS Y.

4) Set ATTEN FACTOR control to 100.

5) Connect signal to INPUT Y.

6) Rotate INPUT X TRIGGER control through its range until GATE OPEN light comes on.

7) Slowly turn TRIGGER control between its extreme positions, and note whether any counting occurs. If counting occurs, proceed to step 9; otherwise, continue on to step 8.

8) Repeat step 7, each time reducing the attenuation factor, i.e., 10, 1, until counting occurs. If no counting occurs in ATTEN "1", determine if an adequate input signal is present.

9) By turning the TRIGGER control, determine the positions which start and stop the counting, then set the control midway between these two positions.

10) Refer back to Mode of Operation section (Section 2.6) for further information on mode being used.

2.8 ACCURACY

Accuracy of a measurement depends on the sum of errors contributed from four sources: the gating action, the internal time standard, the input signal (that does not truly represent the event being measured), and the resolution of the instrument.

2.8.1 Error Due to Gating Action

Figure 2-14 shows how gating action may cause the indication to be in error as much as ±1 count. If the gate opens just before one clock pulse and closes immediately after another, the indication may be one time unit high. But if the gate opens just after a pulse and closes just before another, the indication may be one time unit low. In no case will the error be greater than one time unit. In TIM and PERIOD measurement, this error will be very slight if the time units chosen are small in comparison to the interval being timed.

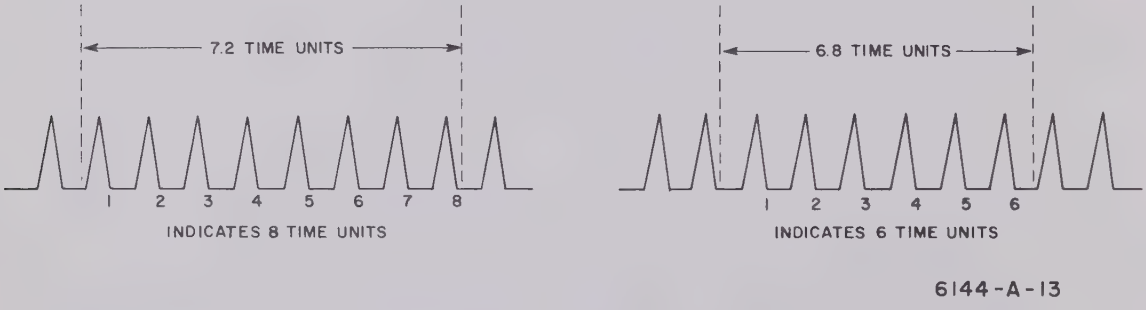


FIG. 2-14. Illustrates how gating action may cause an error of one time unit.

2.8.2 Error Due to Internal Time Standard

The internal time standard is a crystal oscillator housed in a thermostatically controlled chamber. The oscillator is subject to deviations from an absolute standard, and may change frequency during the interval between two calibrations. Once set, the oscillator will not vary more than 3 parts in 10^7 per week. This means that measurements made within the same week can be compared with a maximum error of 0.00002 percent. If absolute (as distinguished from comparative) time is important, the oscillator may be periodically adjusted to correspond with the standard frequencies broadcast from the National Bureau of Standards radio stations, WWV or WWVH.

2.8.3 Error Due to a Non-Representative Input Signal

The instrument begins timing at the instant the input excursion passes through the trigger voltage level. If the input contains "noise (where noise is defined as any voltage variation not representative of the event being timed), the noise may cause the input voltage to reach the trigger level too early. Figure 2-15 shows what happens if the noise is a higher frequency imposed on the ideal input signal.

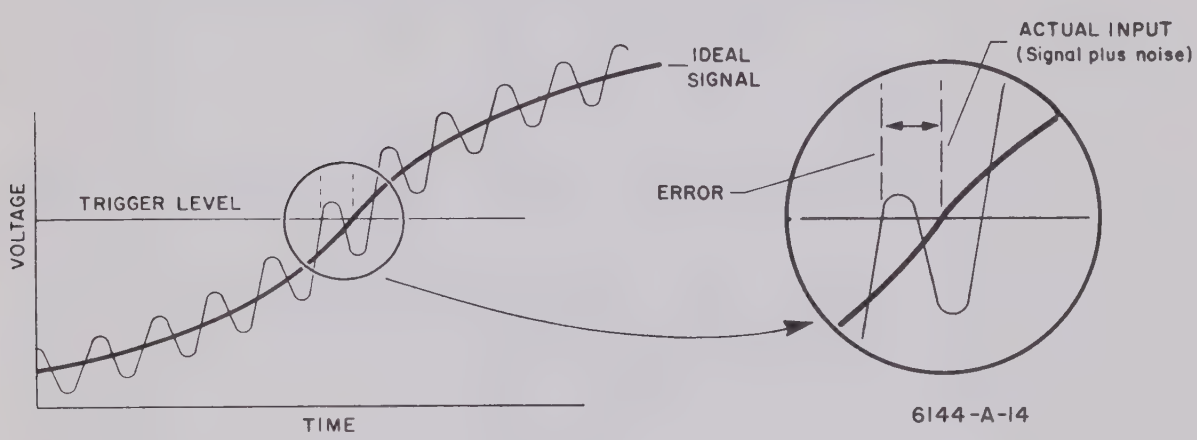


FIG. 2-15. Illustrates how noise may cause a timing error.

The best way to avoid error is to use a noise-free signal of the largest acceptable amplitude. A fast rise time will reduce the error greatly. Figure 2-16 shows that, given two voltage excursions will equal noise, the one with the faster rise time will cause less error.

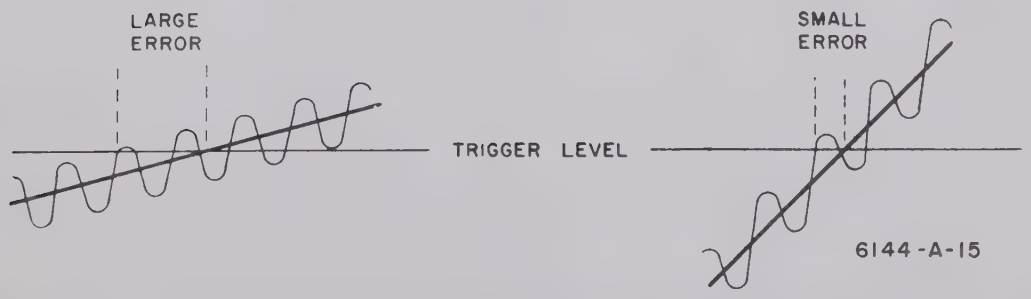


FIG. 2-16. Illustrates how reducing the rise time of a signal will reduce error due to noise.

The error due to noise can be calculated by the following formula:

$$t = \frac{E_n}{S}, \text{ where}$$

t = maximum possible error in seconds

E_n = peak-to-peak noise in volts

S = slope (volts per second) of ideal signal at trigger point.

2.8.4 Resolution Error

The minimum time that must elapse between events if both are to be counted is called the resolution time of the instrument. This instrument has a resolution time of better than 0.4 microseconds for frequency measurements.

Resolution error becomes important when random events are counted. One such event may occur immediately after another, before the counting circuits are fully recovered and prepared to register it. The second event will not only fail to cause a count but its effect on the circuits may also cause a third event to fail to register.

2.9 AUXILIARY CONNECTORS

2.9.1 Digital Recorder Jack

This multi-terminal socket, wired to the readout lines of each storage binary, makes available 1-2-4-8 binary-coded signals for use with such auxiliary equipment as printers, display units, and data converters. Table 2-5 shows the binary code generated by the storage binaries for each decimal digit registered. A "0" means an output level of about -10 volts with respect to ground and with current limited to 0.2 ma; a "1" means a level at ground or -0.3 volts with respect to ground and with current limited to 5 ma. Table 2-6 lists the pin connections to each storage binary.

Pin 39 carries a control signal from the counter to the recorder. This pin is negative (-10 volts or more) for 50 ms, and at approximately ground potential from the time of reset until the next accessory command.

Pin 40 carries an "inhibit recycle" signal from the accessory to the counter. When this pin is grounded the instrument cannot recycle.

Pins 35 and 38 are grounded.

Pins 29 through 32 are not used.

Table 2-5

FOUR-LINE BINARY CODE				
DECIMAL DIGIT REGISTERED	First Binary Stage (Weight 1)	Second Binary Stage (Weight 2)	Third Binary Stage (Weight 4)	Fourth Binary Stage (Weight 8)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

Use Table 2-5 to convert a coded digit to a decimal digit. Note the weight of each column in which a "1" appears, then sum the weights. For example, the coded digit "1100" is equivalent to 1+2+0+0 = 3; and "1001" is equivalent to 1+0+0+8 = 9.

Table 2-6

	PIN NO. ON DIGITAL RECORDER SOCKET			
	First Binary Stage	Second Binary Stage	Third Binary Stage	Fourth Binary Stage
Highest order digit read	Pin 28	Pin 27	Pin 26	Pin 25
2nd highest order digit	4	3	2	1
3rd highest order digit	8	7	6	5
4th highest order digit	12	11	10	9
5th highest order digit	16	15	14	13
6th highest order digit	20	19	18	17
7th highest order digit	24	23	22	21

2.9.2 TIME Jack

An output signal from the time-base generator is available at this jack. The signal is a +6 volt, 0.15 μsecond pulse in series with 3.3 kohms. These pulses are accurately spaced at the interval indicated by the TIME selector and, except when MODE selector is at TEST or E/UT X, can be used externally as a clock signal. See Figure 2-17.

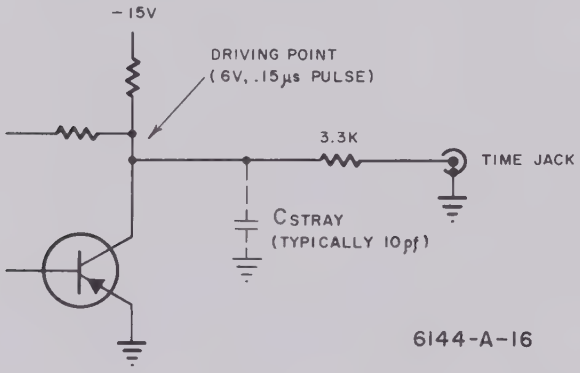


FIG. 2-17. Clock signal output circuit.

2.9.3 FREQ Jack

When the EXT-INT switch is at EXT, an external signal can be introduced at this jack to substitute for the oscillator signal. The external signal must be capable of producing 1 volt rms across 1 kΩ. Frequencies from 50 kc to 2.5 mc are suitable. Frequencies below 50 kc can be used if the internal coupling capacitor is paralleled by a suitable capacitor.

On INT, the oscillator frequency can be monitored.

NOTE

EXT/INT switch must be in INT position for operation of counter unless an external clock is used.

2.9.4 SCOPE Jack

This jack connects through a 15 kΩ resistor to the gate control binary. The voltage at the jack is at ground level when the gate is closed and -10 volts with respect to ground when the gate is open.

2.10 REMOTE PROGRAMMING

Upon request, the instrument can be modified at the factory to include a DPX-57 connector for remote programming. With this modification, external control is possible for the MODE, TIME, RECYCLE RATE controls, and the SLOPE switches.

SECTION 3

SERVICING

3.1 REGULATED POWER SUPPLY ADJUSTMENT

3.1.1 General

There are four adjustments to set the +90, +15, +10, and -15 volt regulated supplies. The +90, +15, and -15 volt adjustments are located on the regulator board and the +10 volt adjustment on the EL supply board. The two boards are located at the rear of the instrument next to the power transformer (see Figure 3-1).

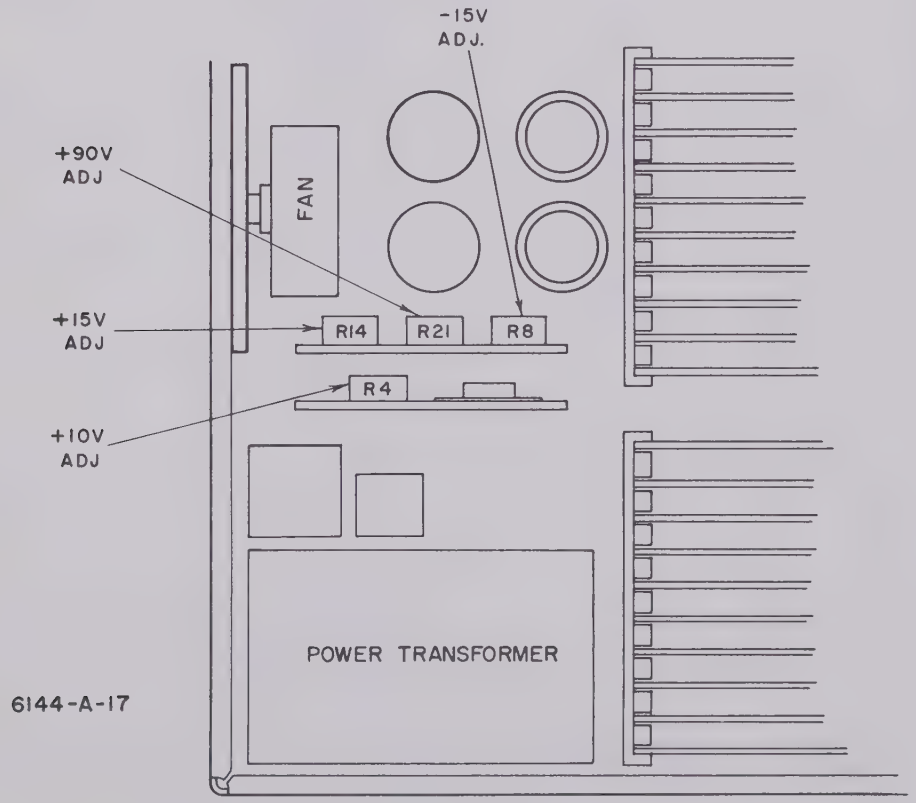


FIG. 3-1. Top view of chassis showing location of +90, +15, +10, and -15 volt adjustments.

3.1.2 Procedure

NOTE

> Do not remove the regulator board from its receptacle without first unplugging the ac line cord from its power source.

1) Use a voltmeter of at least 1% accuracy.

2) Voltage measurements are referenced to chassis ground. See Figure 3-2 for +90, +15, +10, and -15 volt test points.

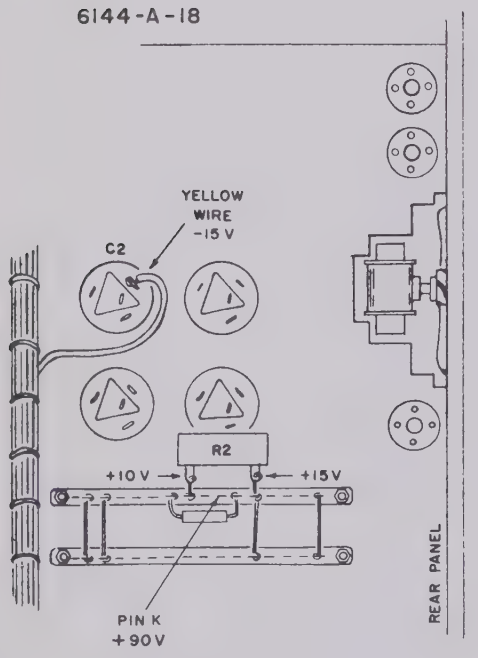


FIG. 3-2. Under chassis view showing location of +90, +15, +10, and -15 volt test points.

3) Remove regulator board from its receptacle. Insert extension board (supplied with instrument) into regulator board receptacle, and insert regulator board at the other end of extension board.

4) Adjust the (+90) potentiometer for +90 volts, ±0.1 volt (see Figures 3-1 and 3-2).

   Adjust the (+15) potentiometer for +15 volts, ±0.2 volt (see Figures 3-1 and 3-2).

   Adjust the (-15) potentiometer for -15 volts, ±0.2 volt (see Figures 3-1 and 3-2).

5) Remove extension board and return regulator board to its receptacle.

6) Remove EL supply board from its receptacle. Insert extension board into EL receptacle and plug EL supply board into other end of extension board.

7) Adjust the (+10) potentiometer for +10 volts, ±0.2 volt (see Figures 3-1 and 3-2).

8) Return EL supply board to its receptacle.

3.2 OSCILLATOR ADJUSTMENT

3.2.1 Procedure

Oscillator adjustments are seldom required. When necessary use this procedure:

1) Adjustment of C1

   a) Use Figure 3-3 to locate trimmer adjustment C1.

   b) Use an oscilloscope (such as Tektronix Model 531) of at least 10 megohms input impedance paralleled with approximately 15 pf; otherwise, loading may change the oscillator frequency.

   c) Connect the output from FREQ Jack J4 to the vertical input of the scope. Then, couple a 1 mc standard to the horizontal input and adjust C1 for a circular Lissajous pattern indicating equal frequencies.

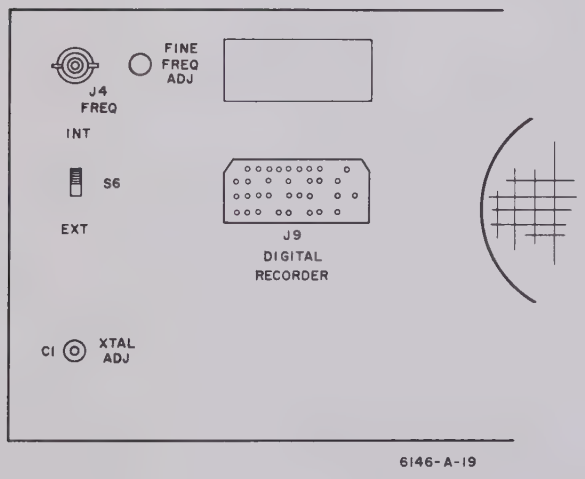


FIG. 3-3. Rear panel view showing location of Crystal Adjust (C1).

3.3 ATTENUATOR ADJUSTMENT

The ceramic trimmer capacitor on each attenuator assembly must be adjusted to prevent the attenuator from distorting the input signal.

3.3.1 Procedure

Refer to Figure 3-4 for location of trimmer adjustments. Equipment needed: Square Wave Generator (Tektronix Type or equivalent), and an Oscilloscope (Tektronix Type 581 or equivalent).

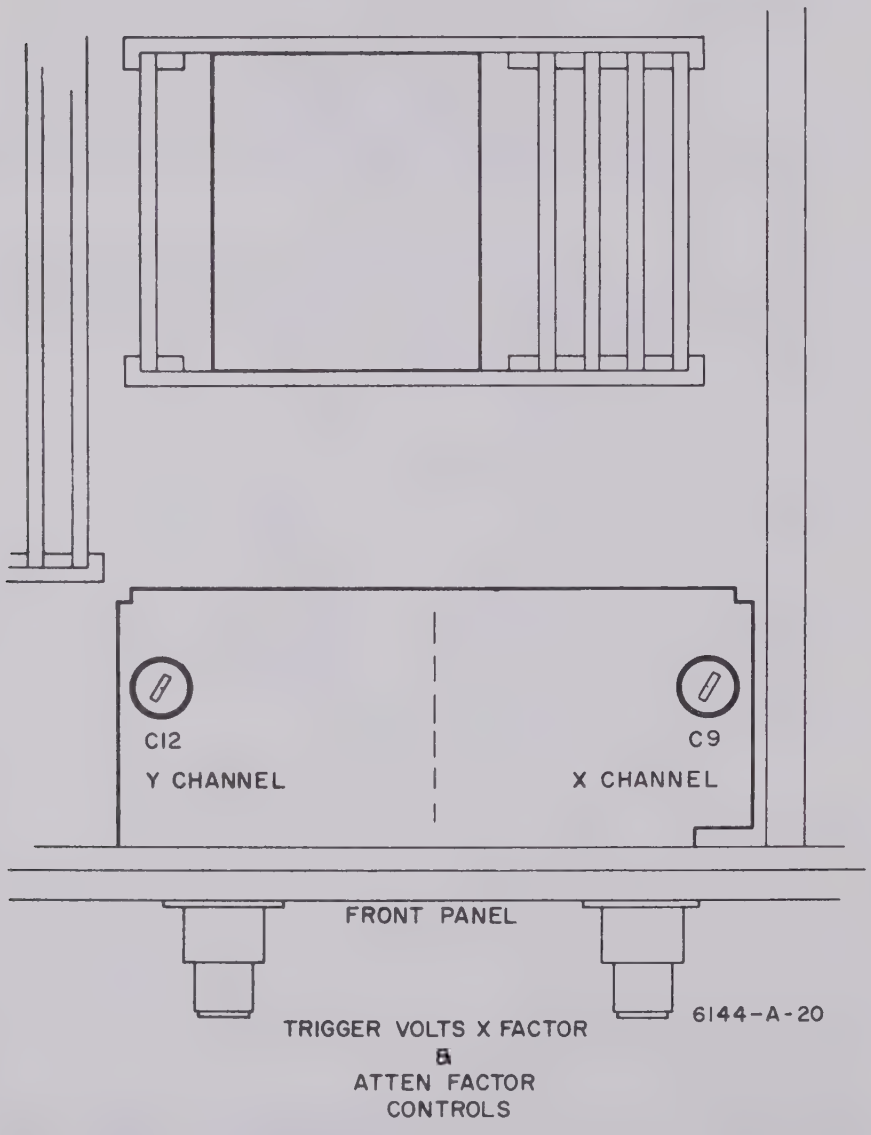


FIG. 3-4. Top view of chassis showing location of ATTEN Selector Frequency compensating capacitors.

1) Make sure both amplifier boards are in place.

2) Connect the Square Wave Generator to INPUT X. Terminate (at instrument) with a 50Ω resistor.

3) Set ATTEN Selector (INPUT X) to AC 10. Apply a 2v p-p, 10kc signal to the input.

4) Monitor with an oscilloscope at pin A of XA18 (input X amplifier) the output of the attenuator. Adjust trimmer C9 for maximum flatness of the square wave.

5) Connect the Square Wave Generator to INPUT Y. Terminate (at instrument) with a 50Ω resistor.

6) Set ATTEN Selector (INPUT Y) to AC 10. Apply a 2v p-p, 10kc signal to the input.

7) Monitor with an oscilloscope at pin A of XA17 (input Y amplifier) the output of the attenuator. Adjust trimmer C12 for maximum flatness of the square wave.

CONTENTS

	Page		Page
Option AA	1	Option AH	3
Option AB	1	Option A1	4
Option AC	2	Option A2	4
Option ACM	2	Option A3	4
Option AD	3	Option A4	4
Option AE	3	Option A5	4
Option AF	3	Option A6	4
Option AG	3	Option A7	4

Table 1. Available and Standard Options 5

Option AA Drawings and Parts Lists:
- 1 MHz Oscillator and Shaper Component Layout (A411676) 6
- 1 MHz Oscillator and Shaper Schematic (C411996) 6a
- 1 MHz Oscillator Assembly Schematic (B416235) 6b

Option AB Drawings and Parts Lists:
- 1 MHz Precision Oscillator Component Layout (A411757) 7
- Oscillator Buffer and Shaper Component Layout (A411759) 7
- 1 MHz Precision Oscillator Schematic (C412391) 7a
- Temperature Sensor Component Layout (B422710) 8
- Temperature Control Component Layout (B422713) 8
- Temperature Control, SCR Mode, Schematic (C422707) 8a

Option ACM Drawings and Parts List:
- 1 MHz Shaper and Divider Component Layout (C434690) 9
- 1 MHz Shaper and Divider Schematic (C434693) 9a
- 1 MHz Timing Module Schematic (C435437) 9b

Option AD Drawings and Parts List:
- Remote Program Component Layout (A421451) 10
- Remote Program Matrix Diagram (C418543) 10a
- Remote Unit Logic Schematic, 6126/44/46 - (D421974) 11a
- Remote Unit Logic Schematic, 6127/47 - (D418542) 12a

MODEL 6100 SERIES OPTIONS

NOTE

Each 6100 Series option is briefly described below. Applicable assembly drawings (with parts lists) and schematic diagrams are located at the end of the writeup.

Table 1 lists the options that are available and standard for each instrument.

OPTION AA

This option substitutes a medium-stability oscillator (3 parts in 10^7 per week) for the precision oscillator (2 parts in 10^8 per week average).

Specifications for the medium-stability oscillator are as follows:

OPTION AA SPECIFICATIONS

Frequency:	1 MHz
Stability:	3 parts in 10^7 per week with ±10% line variation and ±10 degrees C temperature variation.

OPTION AA DRAWINGS

	Dwg. No.	Page
1 MHz Oscillator and Shaper Component Layout	A411676	6
1 MHz Oscillator and Shaper Schematic	C411996	6a
1 MHz Oscillator Assembly Schematic	B416235	6b

OPTION AB

In instruments with Option AB, a high-stability oscillator (2 parts in 10^8 per week average) replaces the medium-stability oscillator.

Specifications for the high-stability oscillator are as follows:

OPTION AB SPECIFICATIONS

Frequency:	1 MHz
Stability	
Short Term:	Less than 3 parts in 10^9 per 24 hours average;
	Less than 1 part in 10^9 standard deviation.
Long Term:	Less than 2 parts in 10^8 per week average;
	Less than 5 parts in 10^9 standard deviation.
Frequency vs. Ambient Temp:	Less than 2 parts in 10^{10} per degree C over the range -20^oC to $+55^oC$.

OPTION AB DRAWINGS

	Dwg. No.	Page
1 MHz Precision Oscillator Component Layout	A411757	7
Oscillator Buffer and Shaper Component Layout	A411759	7
1 MHz Precision Oscillator Schematic	C412391	7a
Temperature Sensor Component Layout	B422710	8
Temperature Control Component Layout	B422713	8
Temperature Control, SCR Mode, Schematic	C422707	8a

OPTION AC

The AC Oscillator is an increased stability version of the AB unit. (Note that the oscillator circuitry is identical to that used in Option AB.)

Specifications for this oscillator are as follows:

OPTION AC SPECIFICATIONS

Frequency:	1 MHz
Stability	
Short Term:	Less than 3 parts in 10^9 per 24 hours.
Long Term:	Less than 2 parts in 10^8 per week.
Frequency vs. Ambient Temp:	Less than 8 parts in 10^9 per degree C over the range -20°C to +60°C.

OPTION ACM

Option ACM (Timing Module) offers an ultra-high stability oscillator with excellent retrace characteristics in a fast warm-up oven.

Specifications for the Timing Module are as follows:

OPTION ACM SPECIFICATIONS

Frequency	1 MHz
Stability	
Short Term:	Less than 8 parts in 10^{10} of the average frequency when 1000 continuous measurements are made with one second averaging periods under constant environmental and voltage conditions.
Long Term:	Less than 1 part in 10^9 per 24 hours after 72 hours of uninterrupted application of power under constant environmental and voltage conditions. Typically, less than 1 part in 10^9 per hour after 1 hour of uninterrupted application of power.
Frequency vs. Ambient Temp:	Less than 2 parts in 10^{10} per degree C over the range -20°C to +65°C.
Frequency vs. Line Voltage:	Less than 5 parts in 10^{10} for a ±10% change from 115 volt, 60 Hz normal line voltage.

Associated with the ACM Timing Module is a 1 MHz Shaper and Divider board, part number 887-434690.

OPTION ACM DRAWINGS

	Dwg. No.	Page
1 MHz Shaper and Divider Board Component Layout	C434690	9
1 MHz Shaper and Divider Board Schematic	C434693	9a
1 MHz Timing Module Schematic	C435437	9b

OPTION AD

Instruments with Option AD have a DPX-57 rear-panel connector with mating plug for remote programming. With this option, external control is possible for the MODE, TIME, RECYCLE RATE, RESET, and SLOPE controls.

OPTION AD DRAWINGS

	Dwg. No.	Page
Component Assembly	A421451	10
Remote Matrix Diagram (6126/27/44/46/47)	C418543	10a
Schematic (6126/44/46)	D421974	11a
Schematic (6127/47)	D418542	12a

A Model 6100 Series instrument can be programmed with either contact closures or transistor switching. However, if the instrument is used with a plug-in (other than Basic Plug-in) contact closures must be used. If transistor switching is desired, contact the factory.

OPTION AE

This option provides 20-inch travel slides (3 sec., 50 lbs) for rack mounting (part number 307-827601).

OPTION AF

Option AF permits the instrument to be used with a 400 Hz rather than the standard 60 Hz power source. Except for the replacement of the 60 Hz fan motor with a 400 Hz motor, there are no circuit changes.

OPTION AG

With this option, front-panel connectors for INPUT X and INPUT Y are paralleled with connectors on the rear panel. This option applies to the basic instrument only and is not available on plug-in modules.

OPTION AH

Instruments with Option AH have a 222 volt instead of the standard 117 volt primary. Figure 1 shows the AH Option.

The 222 volt transformer can be converted to 117 volt operation by rewiring as shown in Figure 2.

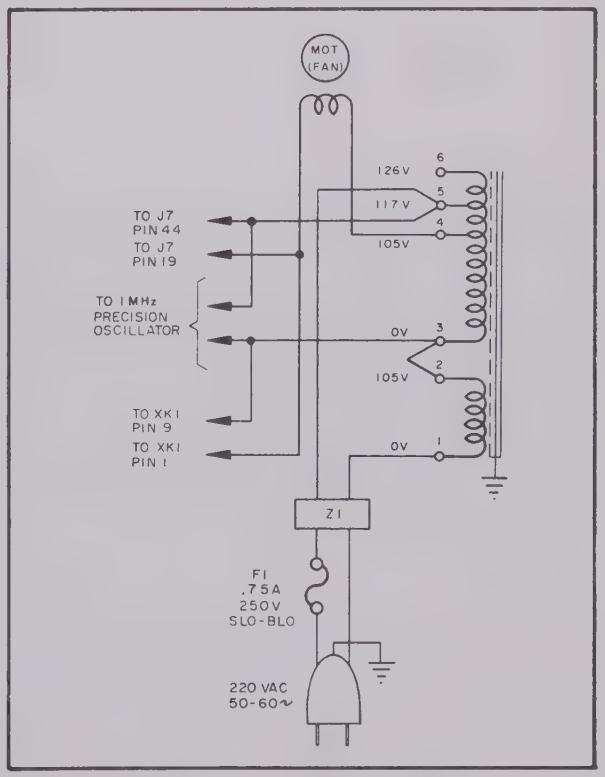


FIG. 1. 222 Volt Primary.

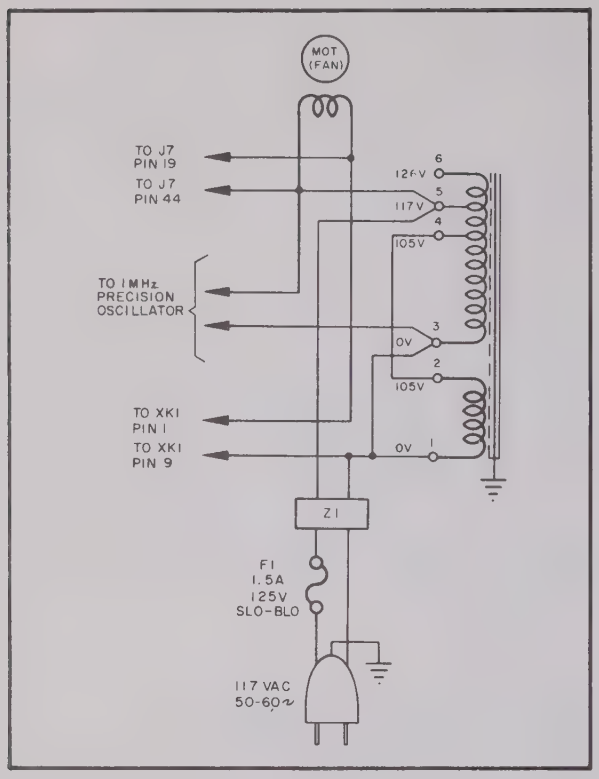


FIG. 2. 117 Volt Primary.

OPTION A1

Option A1 provides a digital recorder output connector (40-pin J9: part number 672-806833, Cannon DPX40-34S) at the rear of the instrument. This multi-terminal socket, wired to the readout lines of each storage binary, makes available 1-2-4-8 binary-coded signals for use with such auxiliary equipment as printers, display units, and data converters.

OPTION A2

Instruments with this option have a 10-second time base position on the TIME selector. Addition of a Model 850 Decimal Counting Unit to the time base divider chain provides this 10-second time base.

OPTION A3

One additional digit of visual, storage, and readout BCD capability is provided with this option.

OPTION A4

Two additional digits of visual, storage, and readout BCD capability is provided with this option.

OPTION A5

Option A5 provides for special paint or front panels.

OPTION A6

This option deletes the blank plug-in (Model 696), rack ears, and extender boards. A front-panel plate is also supplied.

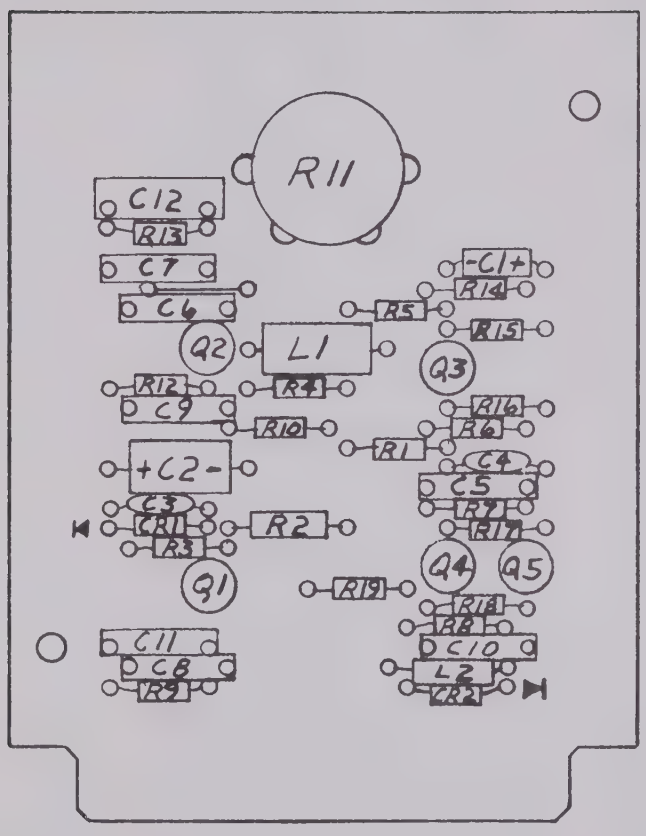
OPTION A7

Option A7 removes SCR Data Storage (DSU) boards and replaces them with Photoelectric Data Storage Units.

TABLE 1

OPTION	MODEL NUMBER									
	6120	6121	6122	6126	6127	6144	6145	6146	6147	6148
AA				*	*		*	*	*	*
AB	*	*	*			*	//			//
AC	*	*	*	*	*	*		*	*	
ACM	*	*	*	*	*	*	*	*	*	*
AD	//	//	//	*	*	*	*	*	*	//
AE	*	*	*	*	*	*	*	*	*	*
AF	*	*	*	*	*	*	*	*	*	//
AG	*	*	*	*	*	*	*	*	*	*
AH	*	*	*	*	*	*	*	*	*	*
A1	*	*	*							
A2	*	*	*							
A3	*	*	*			*				
A4	*	*	*			//				
A5	*	*	*	*	*	*	*	*	*	*
A6	*	*		*	*	*	*	*	*	
A7	*	*	//	*	*	*	//	*	*	//

Standard for the instrument | * Available as an option | // Not available



OPTION AA
1 MHz OSCILLATOR AND SHAPER
COMPONENT LAYOUT

1 MHz OSCILLATOR BOARD

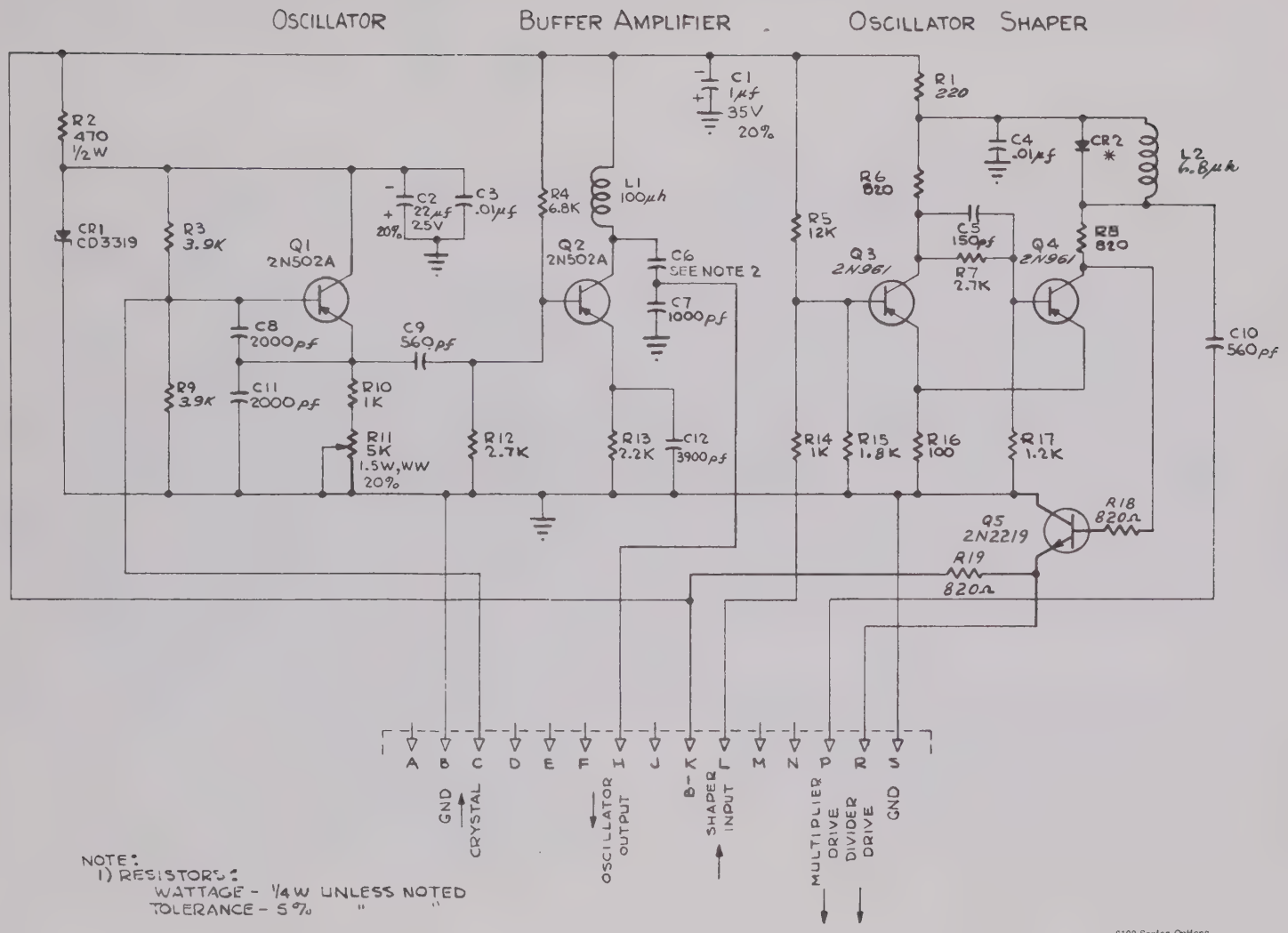
Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
	887-411676	1 MHz Oscillator Board	Beckman	1
C1	631-814053	Capacitor, F. Elect., 1μf, 35V, 20%	Sprague 150D105X0035A2	1
C2	631-802980	Capacitor, F. Elect., 22μf, 25V, 20%	Sprague 109D226X0025C2	1
C3, 4	633-804717	Capacitor, F. Cerm., 0.01μf, 500V	Sprague 29C9B5	2
C5	637-824018	Capacitor, F. Mica, 150pf, 300V, 5%	Arco DM16E151J-300	1
C6	637-824302	Capacitor, F. Mica, 300pf, 300V, 5%	Arco DM16E301J-300	1
C7	637-824028	Capacitor, F. Mica, 1000pf, 300V, 5%	Arco DM16E102J-300	1
C8, 11	637-824301	Capacitor, F. Mica, 2000pf, 300V, 5%	Arco DM20F202-300	2
C9, 10	637-824025	Capacitor, F. Mica, 560pf, 300V, 5%	Arco DM16E561J-300	2
C12	637-824303	Capacitor, F. Mica, 3900pf, 300V, 5%	Arco DM20F392-300	1
CR1	755-811280	Diode, Reference, Sil., 5V min, 5.5V max.	Cont. Devic. CD3319	1
CR2	755-402107	Diode, Special	Beckman	1
L1	795-807904	Inductor, Fixed, R. F., 0.100 mH	National RA-100-P	1
L2	795-827337	Inductor, Fixed, R. F., 0.0068 mH	National NB6.8I	1
Q1, 2	755-817216	Transistor, Germanium, PNP, 75mw max.	Philco 2N502A	2
Q3, 4	755-817811	Transistor, Germanium, PNP, 150mw	Motorola 2N961	2
Q5	755-823113	Transistor, Silicon, NPN, 800mw max.	Motorola 2N2219	1
R1	601-822327	Resistor, F. Comp., 220Ω, 1/4W, 5%	Allen Bradley CB2215	1
R2	601-015446	Resistor, F. Comp., 470Ω, 1/2W, 5%	Allen Bradley EB4715	1
R3, 9	601-822460	Resistor, F. Comp., 3.9K, 1/4W, 5%	Allen Bradley CB3925	2
R4	601-822299	Resistor, F. Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	1
R5	601-801803	Resistor, F. Comp., 12K, 1/4W, 5%	Allen Bradley CB1235	1
R6, 8	601-822306	Resistor, F. Comp., 820Ω, 1/4W, 5%	Allen Bradley CB8215	2
R7, 12	601-822295	Resistor, F. Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	2

. . . continued

1 MHz OSCILLATOR BOARD - continued

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
R10, 14	601-822308	Resistor, F. Comp., 1K, 1/4W, 5%	Allen Bradley CB1025	2
R11	611-812859	Resistor, V. WW, 5K, 1-1/2W, 20%	C. T. S. Series 111	1
R13	601-822328	Resistor, F. Comp., 2.2K, 1/4W, 5%	Allen Bradley CB2225	1
R15	601-822544	Resistor, F. Comp., 1.8K, 1/4W, 5%	Allen Bradley CB1825	1
R16	601-817735	Resistor, F. Comp., 100Ω, 1/4W, 5%	Allen Bradley CB1015	1
R17	601-822326	Resistor, F. Comp., 1.2K, 1/4W, 5%	Allen Bradley CB1225	1
R18, 19	601-822306	Resistor, F. Comp., 820Ω, 1/4W, 5%	Allen Bradley CB8215	2
	864-412958	Pad, Convertor Transistor	Beckman	5

OPTION AA
1 MHz OSCILLATOR AND SHAPER
SCHEMATIC DIAGRAM



NOTE:
1) RESISTORS:
WATTAGE - 1/4W UNLESS NOTED
TOLERANCE - 5% " "

2) C6 NOMINALLY 300pf. IF OSCILLATOR OUTPUT IS LESS THAN 3V PP, CHANGE TO 330pf

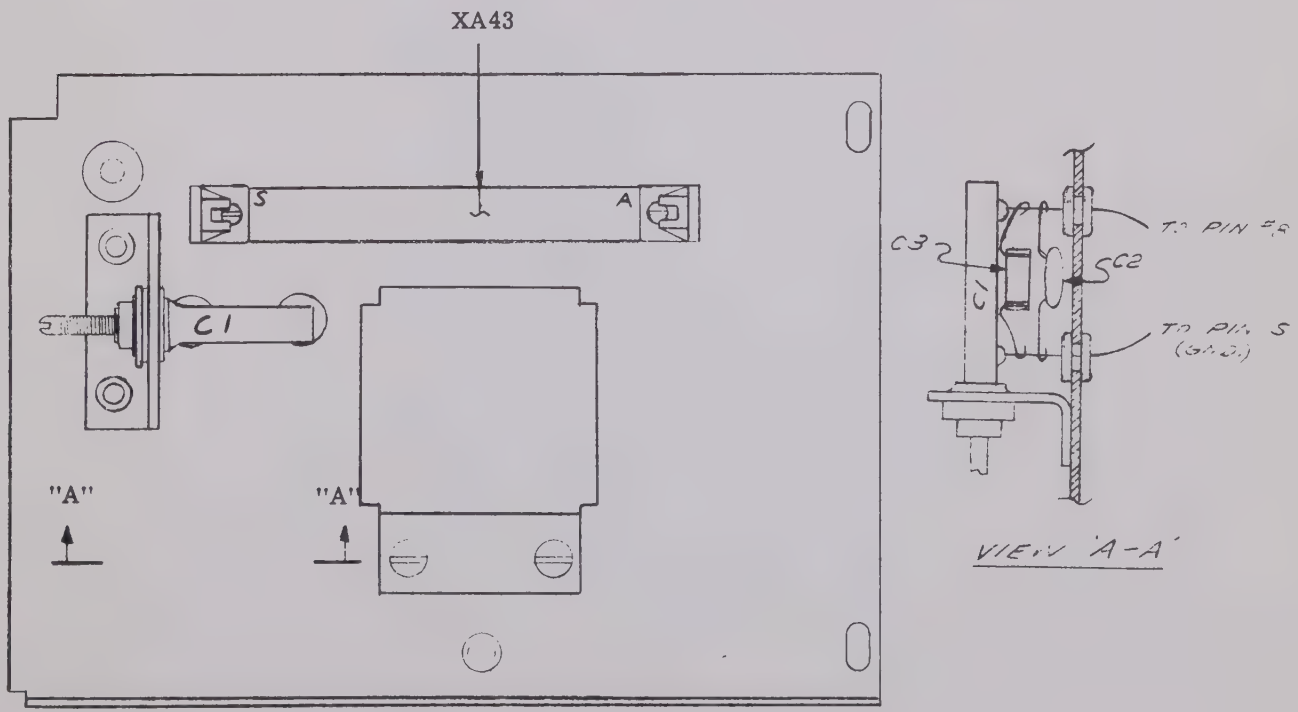
3) CAPACITORS:
TOLERANCE - 5% UNLESS NOTED
VOLTAGE - 300V " "

4) .01µf DISC ARE -20+80%, 500V

Beckman

1 MHz OSCILLATOR ASSEMBLY

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
C1	655-824658	Capacitor, V. Glass, 0.6-14pf, 1000V, -40 to +50 PPM/°C	J. F. D. Elect., VC11GRA (Mod)	1
C2	633-804670	Capacitor, 27pf, 600V, 5%	Erie NPO 332-270J	1
C3	633-827603	Capacitor, F. Cerm., 3.3pf, T. C. -750 PPM/°C	Centralab TCN-3R3	1
C5	639-835127	Capacitor, F. Paper, 3μf, 50V, 10%	Elpac VX5A305K	1
J4	670-806738	Connector, Coaxial, Receptacle, BNC Type	Amphenol UG-1094/U	1
L1, 2	795-807919	Inductor, F. RF, 0.470μH, 9Ω, 285 MA	Delevan 3500-24	2
R3	601-822371	Resistor, F. Comp., 390Ω, 1/4W, 5%	Allen Bradley CB3915	1
S6	716-827410	Switch, Slide, DPDT	Continental Type 126 (C-W)	1
XA43	680-823481	P. C. Connector, 15 Contacts	Cinch 250-15-70-170	1
XY1	860-802333	Socket, Tube, 8-Pin Saddle Mounting	Cinch 16203 (P/O 40-415714)	1
Y1	881-430340	Crystal and Oven Assembly	Beckman	1
	430-415711	Chassis Oscillator	Beckman	1
	864-415712	Insulator, Oven Clamp Bracket	Beckman	1



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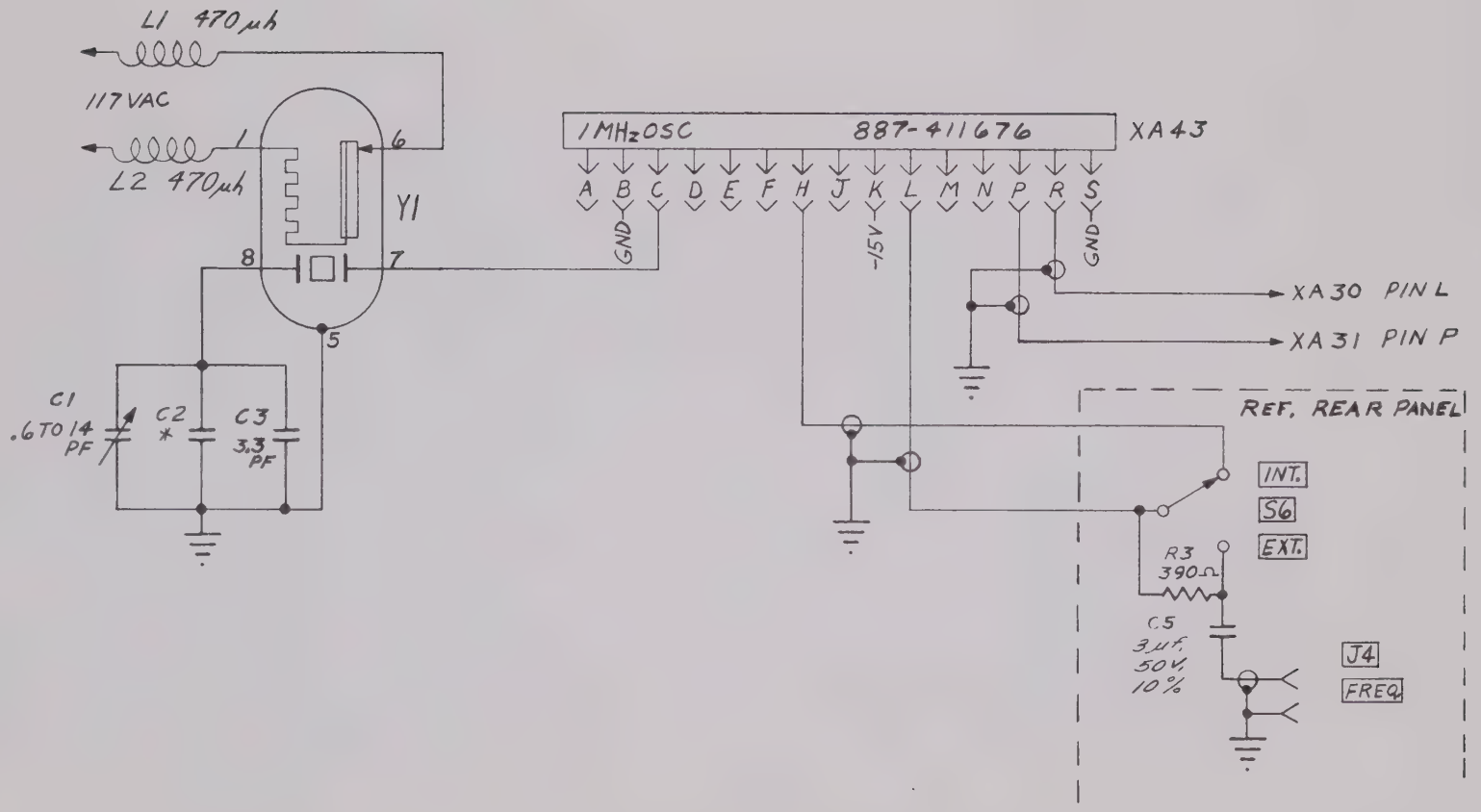
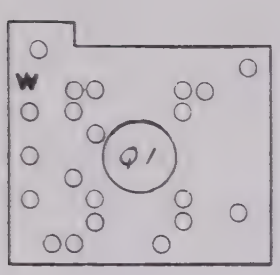
OPTION AA
1 MHz OSCILLATOR ASSEMBLY
SCHEMATIC DIAGRAM

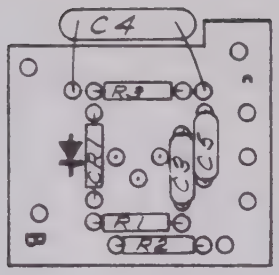


6100 Series Options
B-410235 - Rev. F
June 1967

Beckman®

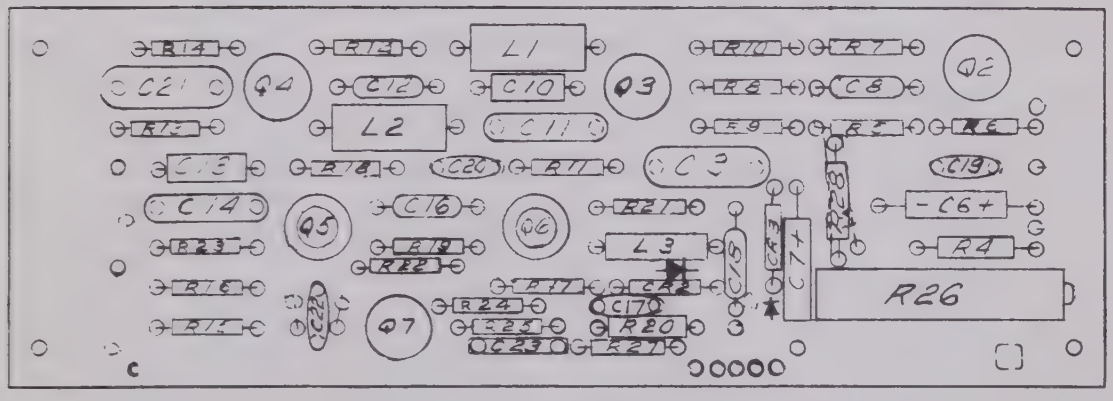


Wire Side



Component Side

OPTION AB
1 MHz PRECISION OSCILLATOR
COMPONENT LAYOUT



OPTION AB
OSCILLATOR BUFFER AND SHAPER COMPONENT LAYOUT

1 MHz PRECISION OSCILLATOR BOARD*

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
	855-423561	1MHz Precision Oscillator Board	Beckman	1
C1	655-824658	Capacitor, V. Glass, 0.6-14pf, 1000V	JFD Elect. VC11GRA-DL	1
C2	633-824491	Capacitor, F. Cerm., NPO, 39pf, 600V, 10%	Skottie TCD-5-NPO	1
C3	637-819380	Capacitor, F. Mica, 150pf, 300V, 5%	Elmenco DM15F151-300	1
C4	637-824825	Capacitor, F. Mica, 3000pf, 300V, 5%	Elmenco DM19F302-300	1
C5	637-819381	Capacitor, F. Mica, 560pf, 300V, 5%	Elmenco DM15F561-300	1
CR1	755-811280	Diode, Reference, Sil., 5.5V, Zener	Cont. Devic. CD3319	1
Q1	755-823113	Transistor, Type 2N2219	Motorola 2N2219	1
R1, 2	601-822324	Resistor, F. Comp., 10K,	Allen Bradley CB1035	2
R3	601-822397	Resistor, F. Comp., 5.6K, 1/4W, 5%	Allen Bradley CB5625	1

OSCILLATOR BUFFER & SHAPER BOARD*

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
		Oscillator Buffer & Shaper Board	Beckman	1
C6, 7	631-802980	Capacitor, F. Elect., 22μf, 25V, $\pm$20%	Sprague 109D226X0025C2	2
C8, 12, 18	637-824025	Capacitor, F. Mica, 560pf, 300V, 5%	Elmenco DM16E561J-300	3
C9, 21	637-824303	Capacitor, F. Mica, 3900pf, 300V, 5%	Elmenco DM20F392-300	2
C10	637-824022	Capacitor, F. Mica, 330pf, 300V, 5%	Elmenco DM16E301J-300	1
C11, 14	637-824028	Capacitor, F. Mica, 1000pf, 300V, 5%	Elmenco DM16E102J-300	2
C13	637-836918	Capacitor, F. Mica, 360pf, 300V, 5%	Elmenco DM16E360J-300	1
C16	637-824018	Capacitor, F. Mica, 150pf, 300V, 5%	Elmenco DM16E151J-300	1
C17, 19, 20, 22	633-804715	Capacitor, F. Ceramic, 0.01μf, 50V	Sprague 19C214	4
C23	633-815873	Capacitor, F. Ceramic, 0.33μf, 25V	Sprague 5C10A	1
CR2	755-402107	Diode, Germanium, Special	Beckman	1
CR3	755-828977	Diode, Zener, 10V, 400ma, 5%	Motorola 1N758A	1

*Part of 1MHz Precision Oscillator Assembly (Part number 855-423561)

. . . continued

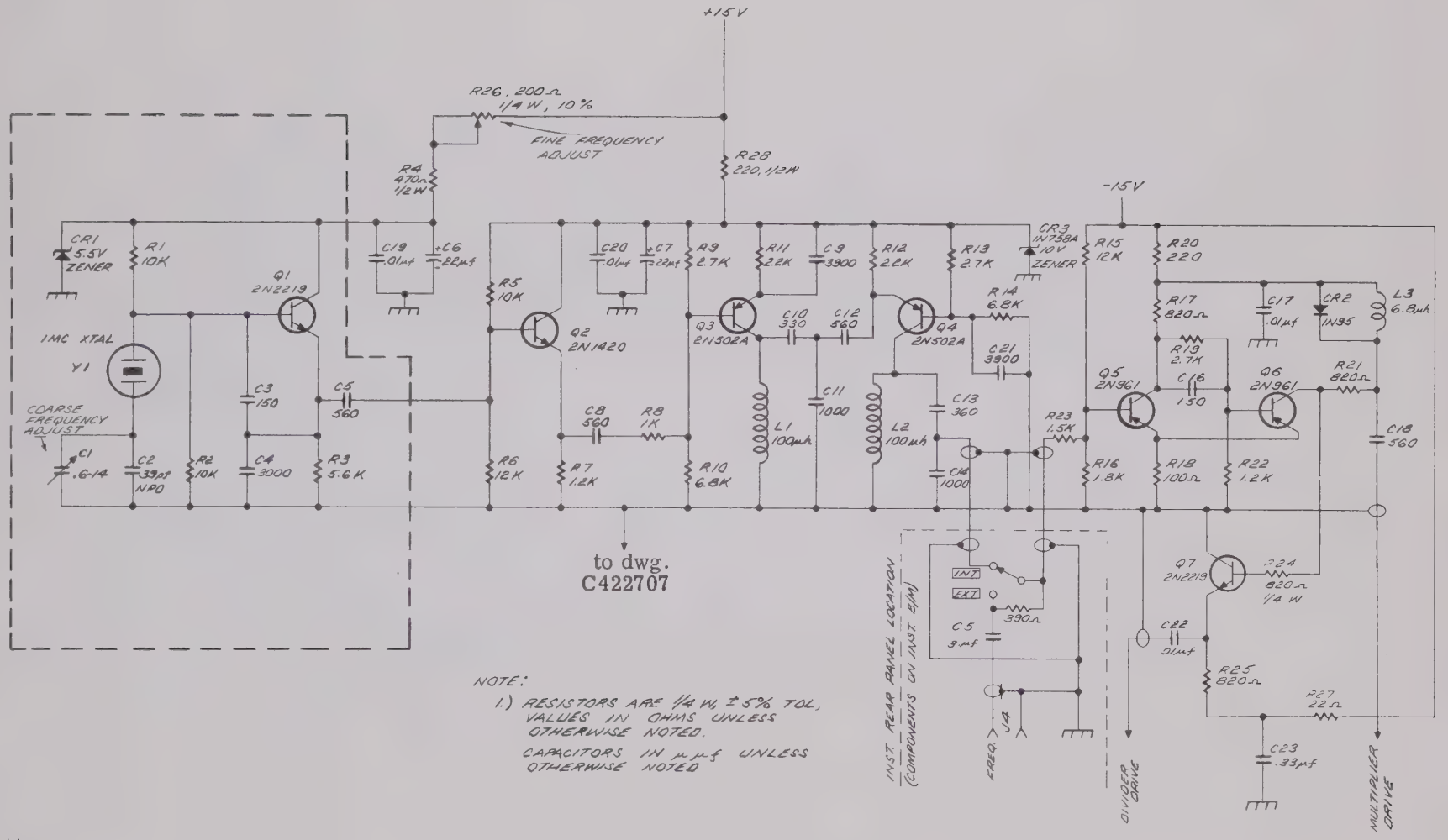
OSCILLATOR BUFFER & SHAPER BOARD - continued

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
L1, 2	795-807904	Inductor, Fixed R.F., 100mh	National RA-100-P	2
L3	795-827337	Coil, 6.8μh, ±10%, 0.40Ω max.	Nat'l Coil NB6.81	1
Q2	755-817964	Transistor, Type 2N1420	P.S.I. 2N1420	1
Q3, 4	755-817216	Transistor	Philco 2N502A	2
Q5, 6	755-817811	Transistor	Motorola 2N961	2
Q7	755-823113	Transistor, Type 2N2219	Motorola 2N2219	1
R4	601-015446	Resistor, F.Comp., 470Ω, 1/2W, 5%	Allen Bradley EB4715	1
R5	601-822324	Resistor, F.Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	1
R6, 15	601-801803	Resistor, F.Comp., 12K, 1/4W, 5%	Allen Bradley CB1235	2
R7, 22	601-822326	Resistor, F.Comp., 1.2K, 1/4W, 5%	Allen Bradley CB1225	2
R8	601-822308	Resistor, F.Comp., 1K, 1/4W, 5%	Allen Bradley CB1025	1
R9, 13, 19	601-822295	Resistor, F.Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	3
R10, 14	601-822299	Resistor, F.Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	2
R11, 12	601-822328	Resistor, F.Comp., 2.2K, 1/4W, 5%	Allen Bradley CB2225	2
R16	601-822544	Resistor, F.Comp., 1.8K, 1/4W, 5%	Allen Bradley CB1825	1
R17, 21, 24, 25	601-822306	Resistor, F.Comp., 820Ω, 1/4W, 5%	Allen Bradley CB8215	4
R18	601-817735	Resistor, F.Comp., 100Ω, 1/4W, 5%	Allen Bradley CB1015	1
R20	601-822327	Resistor, F.Comp., 220Ω, 1/4W, 5%	Allen Bradley CB2215	1
R23	601-822527	Resistor, F.Comp., 1.5K 1/4W, 5%	Allen Bradley CB1525	1
R26	611-806216	Resistor, V. WW, 200Ω, 10%, 1/4W	Bourns 275-1-201	1
R27	601-823383	Resistor, F.Comp., 22Ω, 1/4W, 5%	Allen Bradley EB2225	1
R28	601-022939	Resistor, F.Comp., 220Ω, 1/2W, 5%	Allen Bradley EB2215	1

MISCELLANEOUS PARTS

XY1	680-413787	Socket	Beckman	1
Y1	881-405017	Crystal, Piezoelectric	Beckman	1

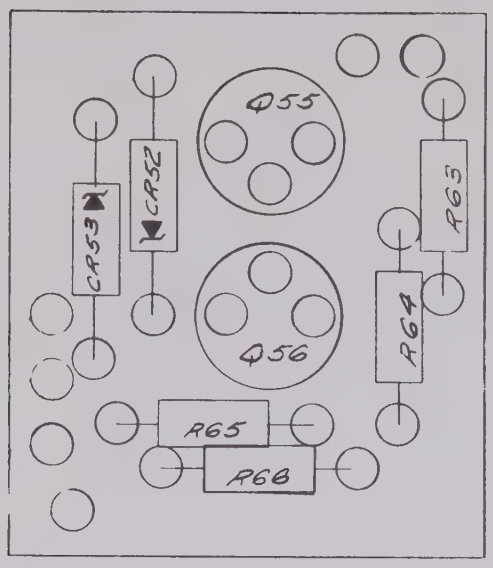
OPTION AB
1 MHz PRECISION OSCILLATOR
SCHEMATIC DIAGRAM



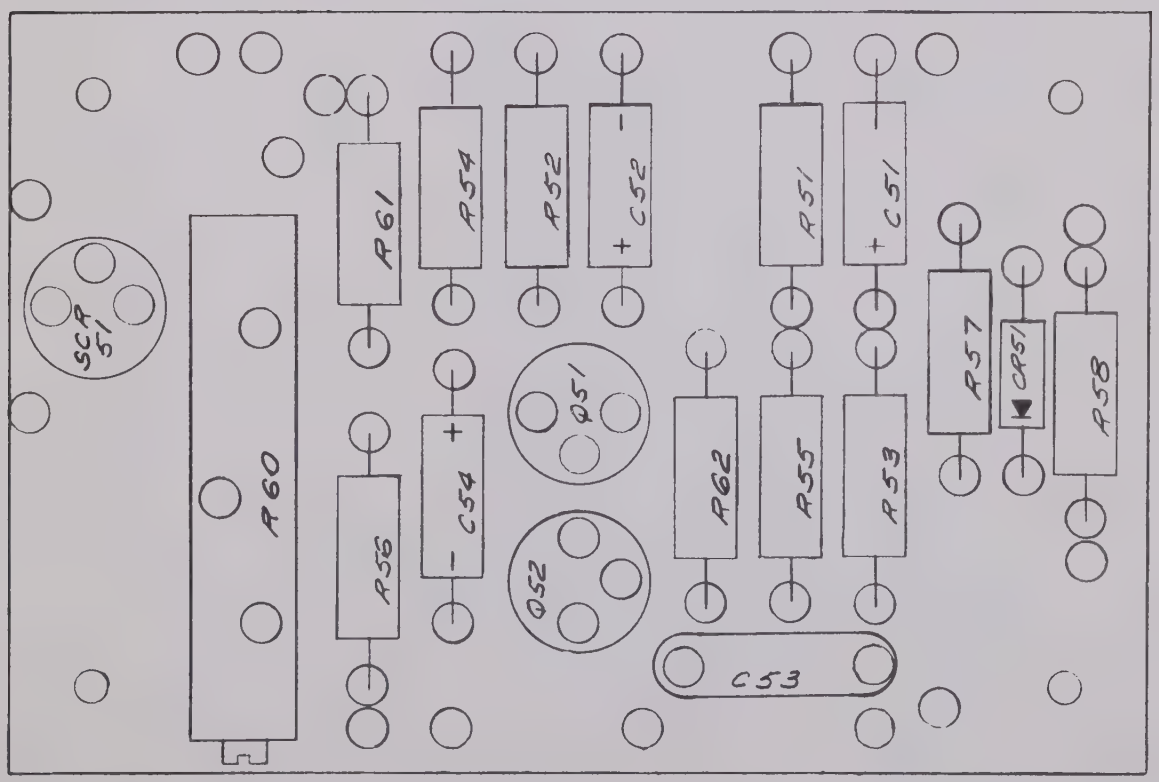
NOTE:
1.) RESISTORS ARE 1/4 W, ± 5% TOL, VALUES IN OHMS UNLESS OTHERWISE NOTED.
CAPACITORS IN μμf UNLESS OTHERWISE NOTED

6100 Series Options
C412391 - Rev. F
June 1967

Beckman



OPTION AB
TEMPERATURE SENSOR BOARD
COMPONENT LAYOUT



OPTION AB
TEMPERATURE CONTROL BOARD COMPONENT LAYOUT

TEMPERATURE SENSOR BOARD*

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
		Temperature Sensor Board	Beckman	1
CR52, 53	755-818496	Diode, Zener, 5.1V	Motorola 1N751A	2
Q56	755-817964	Transistor, Type 2N1420	P.S.I. 2N1420	1
Q55	755-814332	Transistor, Silicon, 2N1027	Sperry Sim 2N1027	1
R63	601-015039	Resistor, F.Comp., 1.2K, 1/2W, 5%	Allen Bradley EB1225	1
R64	601-015460	Resistor, F.Comp., 3.3K, 1/2W, 5%	Allen Bradley EB3325	1
R65, 66	601-015038	Resistor, F.Comp., 1K, 1/2W, 5%	Allen Bradley EB1025	2

TEMPERATURE CONTROL BOARD*

		Temperature Control Board	Beckman	1
C51, 52, 54	631-802980	Capacitor, F.Elect., 22μf, 25V, ±20%	Sprague 109D226X0025C2	3
C53	637-808468	Capacitor, F.Mica, 3300pf, 500V, 10%	Elmenco DM-20-332	1
CR51	755-402107	Diode, Germanium, Special	Beckman	1
Q51, 52	755-817964	Transistor, Type 2N1420	P.S.I. 2N1420	2
R51	601-079172	Resistor, F.Comp., 820Ω, 1/2W, 5%	Allen Bradley EB8215	1
R52, 54	601-022930	Resistor, F.Comp., 100Ω, 1/2W, 5%	Allen Bradley EB1015	2
R53	601-015447	Resistor, F.Comp., 680Ω, 1/2W, 5%	Allen Bradley EB6815	1
R55	601-800011	Resistor, F.Comp., 270Ω, 1/2W, 5%	Allen Bradley EB2715	1
R56	601-008129	Resistor, F.Comp., 1.5K, 1/2W, 5%	Allen Bradley EB1525	1
R57	601-000897	Resistor, F.Comp., 2.2K, 1/2W, 5%	Allen Bradley EB2225	1
R58	601-800001	Resistor, F.Comp., 2.7Ω, 1/2W, 5%	Allen Bradley EB27G5	1
R60	611-806222	Resistor, V. WW, 2K, 1/4W, 10%	Bourns 200P-1-203	1
R61	xxx-xxxxxx	Resistor (Factory selected value)		
R62	607-829688	Resistor, F.Film, 240Ω, 1/2W, 5%	Stemag SLAD	1
SCR51	774-837861	Silicon Control Rectifier	G.E., 2N2327	1

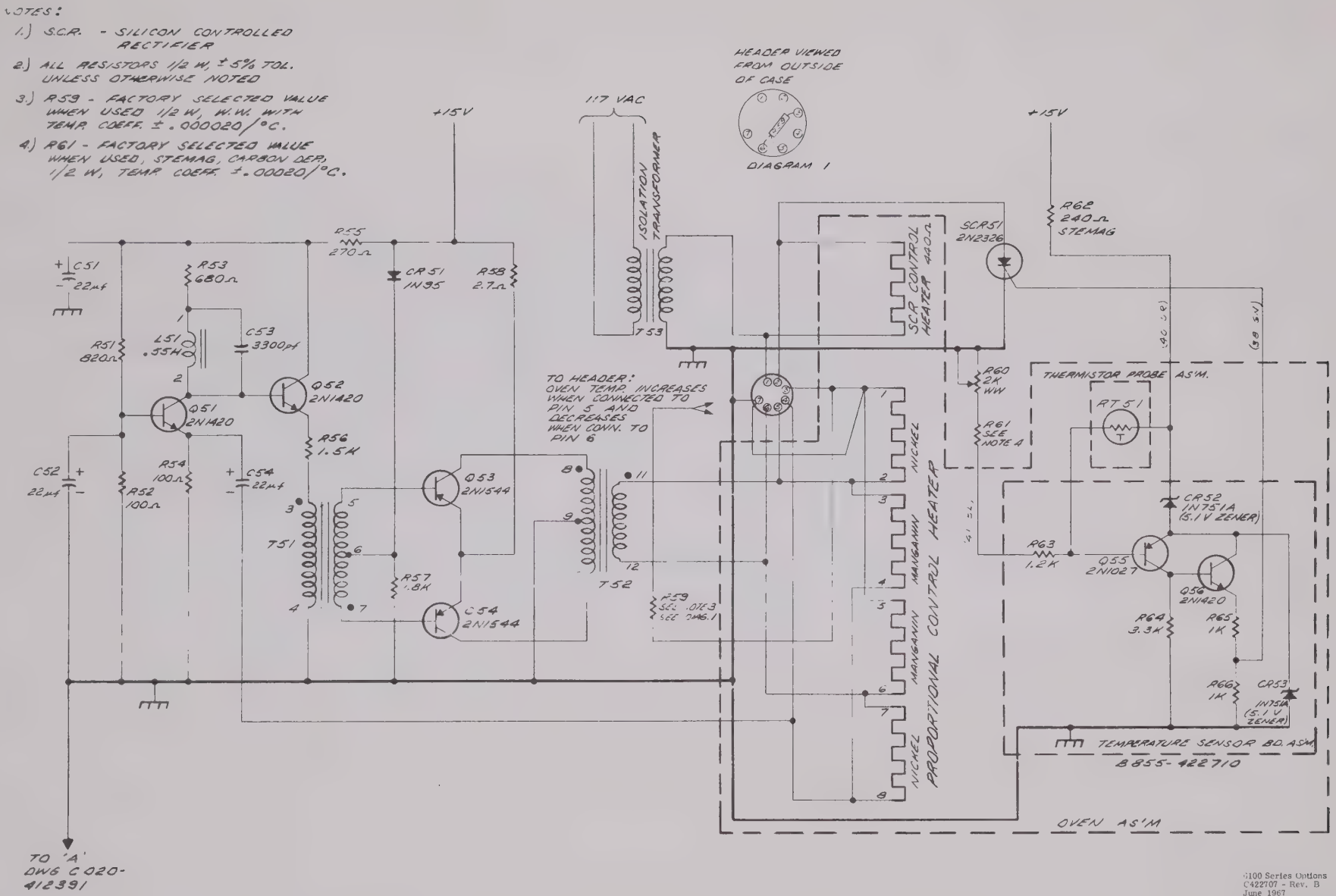
*Part of 1 MHz Precision Oscillator Assembly (Part number 855-423561)

MISCELLANEOUS PARTS

(Temperature Sensor and Temperature Control Boards)

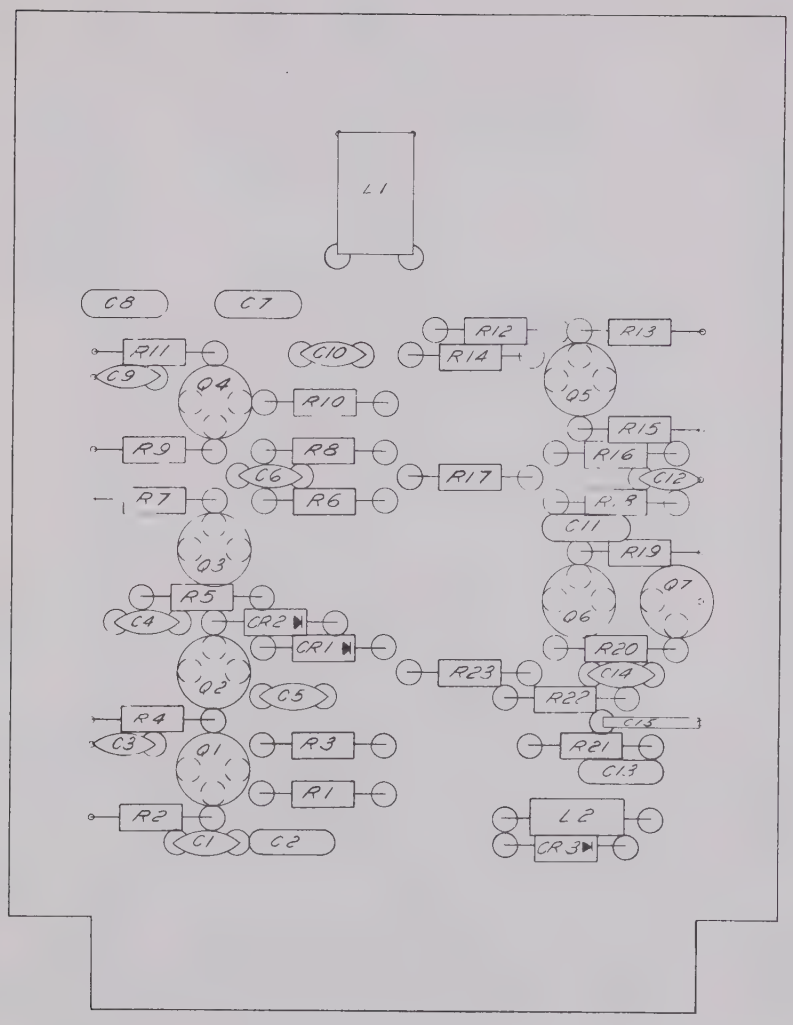
Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
L51	792-422735	Transformer, Special	Beckman	1
Q53, 54	755-822107	Transistor, Power, 90W	Motorola 2N1544	2
R59	601-xxxxxx	Resistor (Factory selected value when used)	Beckman	1
RT51	626-424900	Thermistor, 20K, 20% ea. 25°C	Beckman	1
T51, 52		Transformer, part of L51	Beckman	1
T53	792-422825	Transformer, Special, Isolation	Beckman	1
	695-815672	Terminal, Feed-thru	Fuseite 105 HTL 45°	10
	678-817326	Header, 7-Pin	Fuseite 53-730-40-P1/ FP-7A	1

OPTION AB
TEMPERATURE CONTROL, SCR MODE
SCHEMATIC DIAGRAM



6100 Series Options
C422107 - Rev. B
June 1967

Beckman

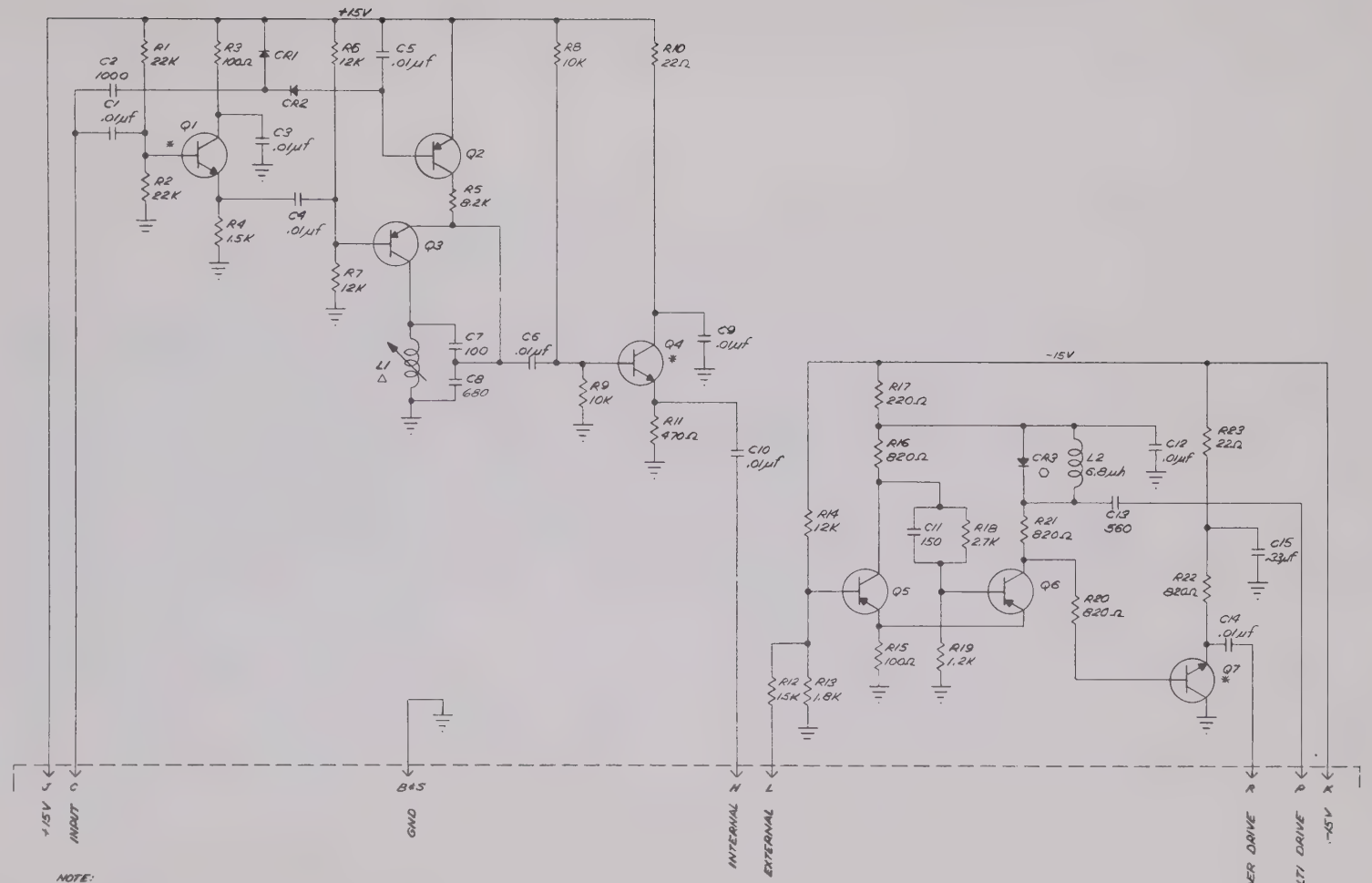


OPTION ACM
1 MHz SHAPER AND DIVIDER COMPONENT LAYOUT

1 MHz SHAPER & DIVIDER BOARD

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
C1, 3, 4, 5, 6, 9, 10, 12, 14	633-836864	Capacitor, F.Cerm., 0.01μf, 50V	Sprague 19C214A6	9
C2	637-822757	Capacitor, F.Mica, 1000pf, 100V, 5%	Electromotive DM15F102J0-100WV4CR	1
C7	637-822251	Capacitor, F.Mica, 100pf, 500V, 5%	Electromotive DM15F101J0-500WV4CR	1
C8	637-825496	Capacitor, F.Mica, 680pf, 300V, 5%	Electromotive DM15F681J0-300WV4CR	1
C11	637-825104	Capacitor, F.Mica, 150pf, 500V, 5%	Electromotive DM15F151J0-500WV4CR	1
C13	637-819381	Capacitor, F.Mica, 560pf, 300V, 5%	Electromotive DM15F561J0-300WV1CR	1
C15	633-815873	Capacitor, F.Cerm., 0.33μf, 25V	Sprague 5C10A	1
CR1, 2	755-431324	Diode, Special, Silicon	Beckman	2
CR3	755-402107	Diode, Special	Beckman	1
L1	795-434743	Inductor, Variable	Beckman	1
L2	795-827337	Inductor, Fixed, 6.8μH, 10%	National NB -6.81	1
Q1, 4, 7	755-419596	Transistor, Special	Beckman	3
Q2, 3, 5, 6	755-425735	Transistor, Special	Beckman	4
R1, 2	601-822334	Resistor, F.Comp., 22K, 1/4W, 5%	Allen Bradley CB2235	2
R3, 15	601-817735	Resistor, F.Comp., 100Ω, 1/4W, 5%	Allen Bradley CB1015	2
R4, 12	601-822527	Resistor, F.Comp., 1.5K, 1/4W, 5%	Allen Bradley CB1525	2
R5	601-822331	Resistor, F.Comp., 8.2K, 1/4W, 5%	Allen Bradley CB8225	1
R6, 7, 14	601-801803	Resistor, F.Comp., 12K, 1/4W, 5%	Allen Bradley CB1235	3
R8, 9	601-822324	Resistor, F.Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	2
R10, 23	601-823383	Resistor, F.Comp., 22Ω, 1/4W, 5%	Allen Bradley CB2205	2
R11	601-823395	Resistor, F.Comp., 470Ω, 1/4W, 5%	Allen Bradley CB4715	1
R13	601-822544	Resistor, F.Comp., 1.8K, 1/4W, 5%	Allen Bradley CB1825	1
R16, 20, 21, 22	601-822306	Resistor, F.Comp., 820Ω, 1/4W, 5%	Allen Bradley CB8215	4
R17	601-822327	Resistor, F.Comp., 220Ω, 1/4W, 5%	Allen Bradley CB2215	1
R18	601-822295	Resistor, F.Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	1
R19	601-822326	Resistor, F.Comp., 1.2K, 1/4W, 5%	Allen Bradley CB1225	1

OPTION ACM
1 MHz SHAPER AND DIVIDER
SCHEMATIC DIAGRAM



NOTE:

TRANSISTORS:
UNCODED PER BECKMAN SPEC. A755-425735
* " " " A755-419596

COIL:
△ IS BECKMAN SPEC. B795-934793

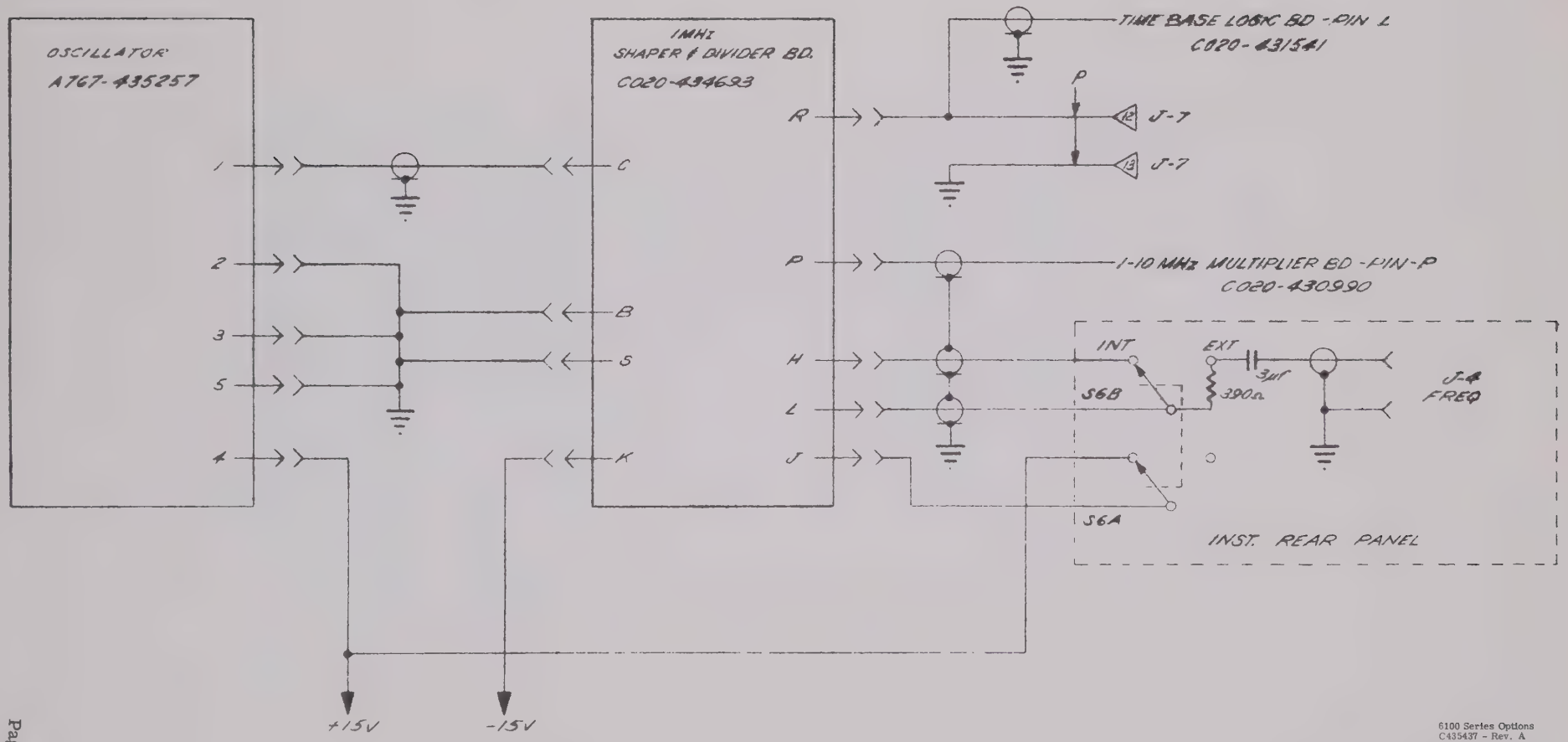
DIODES:
UNCODED ARE BECKMAN SPEC. A755-431329
○ " " " A755-902107

RESISTORS: 1/4W, 5% UNLESS NOTED

CAPACITORS: VALUES IN pf UNLESS NOTED

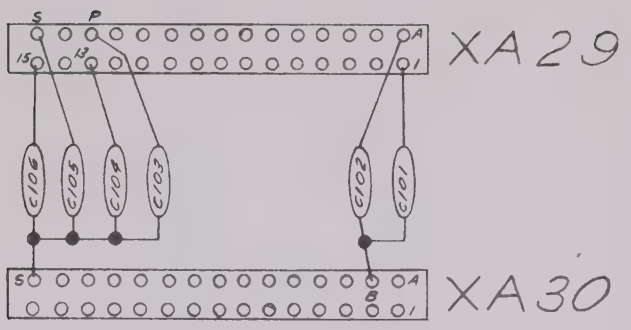
Beckman

OPTION ACM
1 MHz TIMING MODULE
SCHEMATIC DIAGRAM



6100 Series Options
C435437 - Rev. A
June 1967

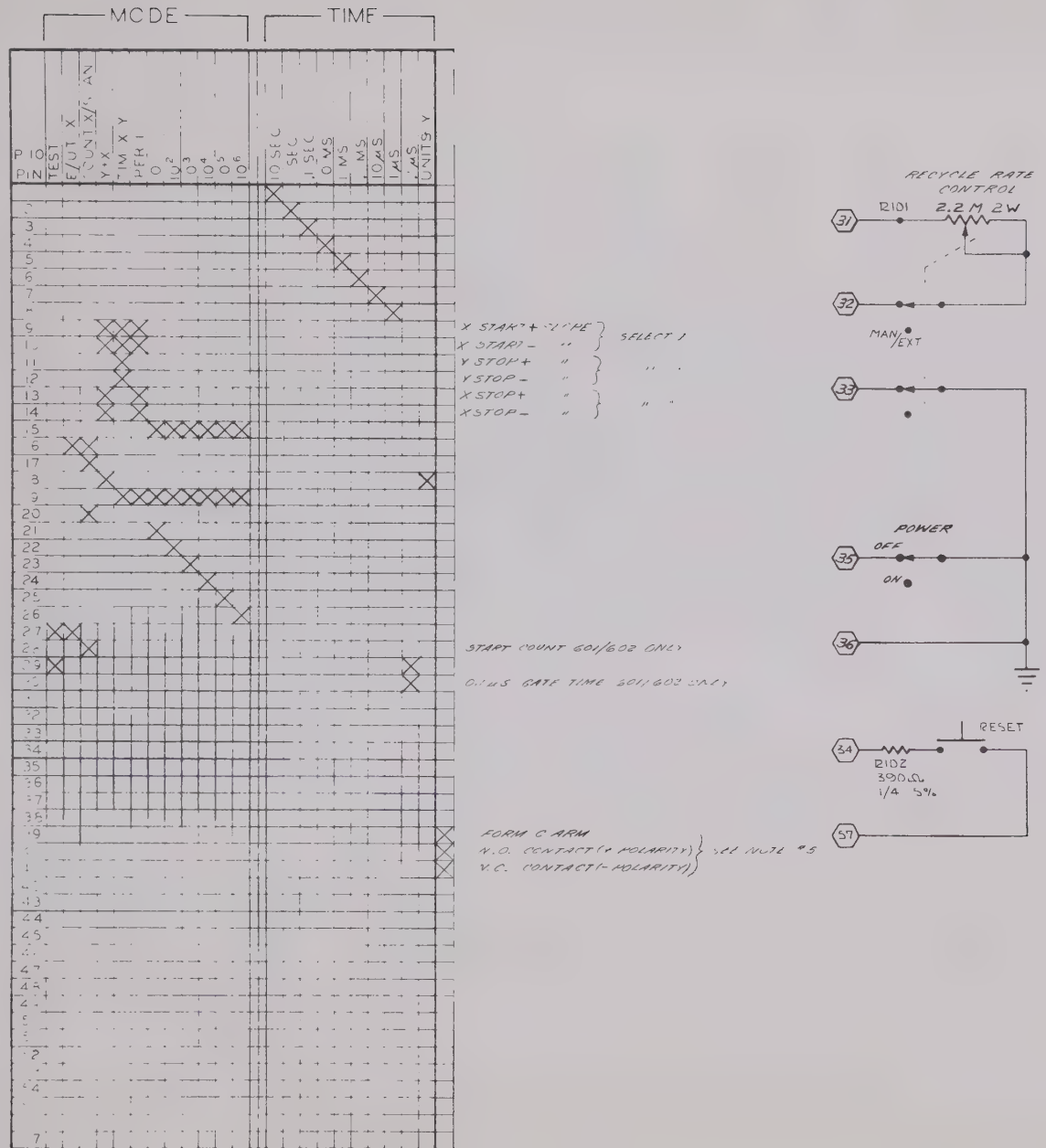
Beckman®



OPTION AD
REMOTE PROGRAM COMPONENT LAYOUT

REMOTE PROGRAM COMPONENT ASSEMBLY

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
C101 thru C106	633-804717	Capacitor, F.Cerm., 0.01μf, 500V	Sprague 29C9B5	6
J10	672-806840	Connector, Receptacle, 57 Contacts, female	Cannon DPX-57-34S	1
P10	672-806839	Connector, Plug, 57 Contacts, male	Cannon DPX-S7-34P	1
R101	601-822308	Resistor, F.Comp., 1K, 1/4W, 5%	Allen Bradley CB1025	1



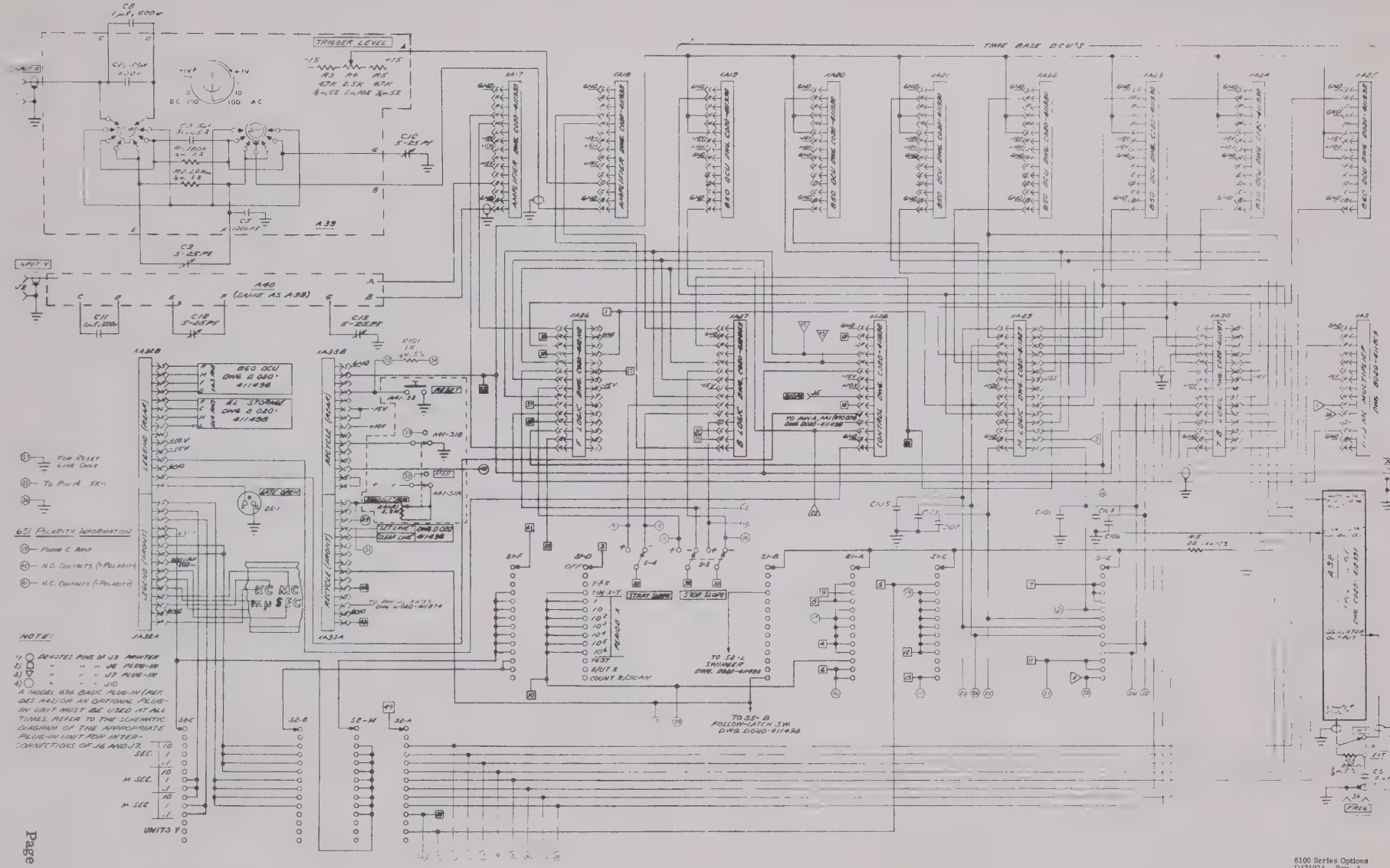
NOTE:

1. USE .1 µS ONLY IN TIM X-Y PER X.
2. SEE INSTRUCTION MANUAL TABLE 2-2 FOR INCOMPATABLE MATRIX COMBINATION.
3. ☒ TIE THIS PIN TO SIGNAL GND (PIN 36)
   EXAMPLE:
   IF E/UT X5 @ 1 MS TIME BASE ARE SELECTED, GROUND PINS 5, 16, 27.
4. IF A TRANSISTOR SWITCH IS USED FOR #3 ABOVE, IT MUST BE OPERATED IN THE SATURATED CONDITION, TURNED ON (PNP).
5. THIS POLARITY INFORMATION IS AVAILABLE ONLY WHEN 651 PLUG-IN IS EMPLOYED.

6100 Series Options
C418543 - Rev. C
June 1967

Beckman

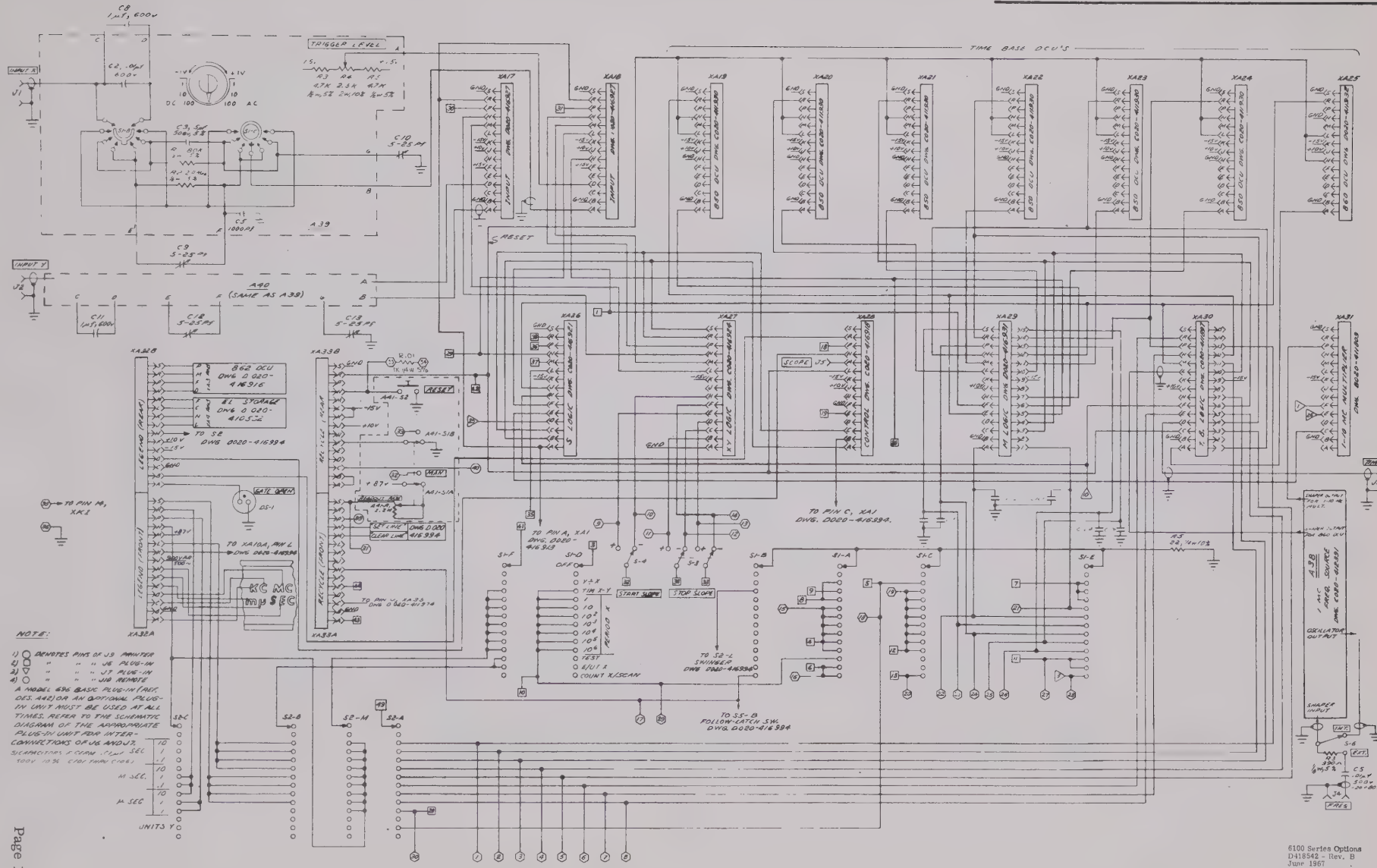
OPTION AD
REMOTE UNIT LOGIC
SCHEMATIC DIAGRAM (Models 6126/44/46)



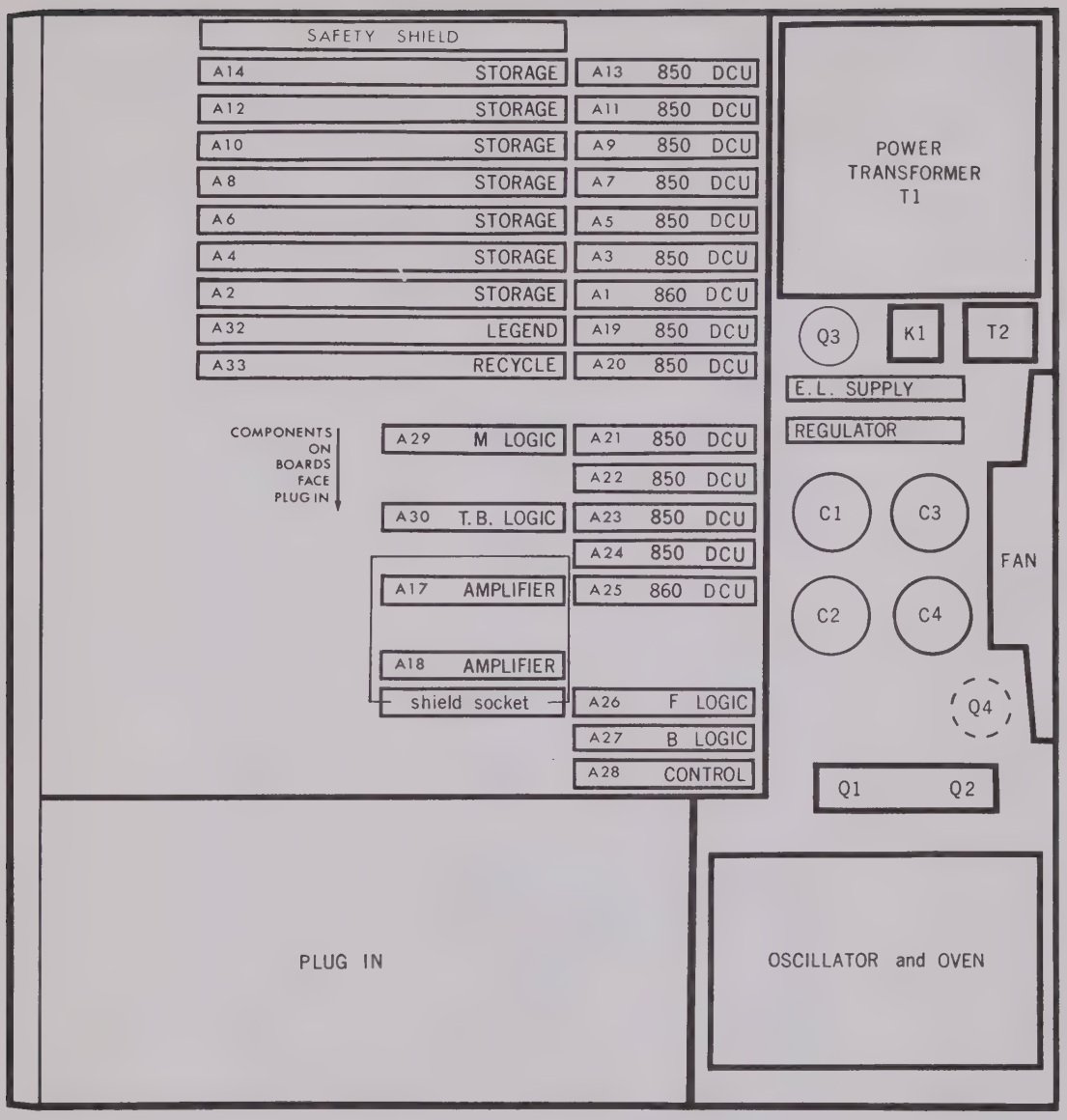
6100 Series Options
D4211974 - Rev. A
June 1967

Beckman

OPTION AD
REMOTE UNIT LOGIC
SCHEMATIC DIAGRAM (Models 6127/6147)



Beckman



Beckman EPUT and TIMER MODEL 6144

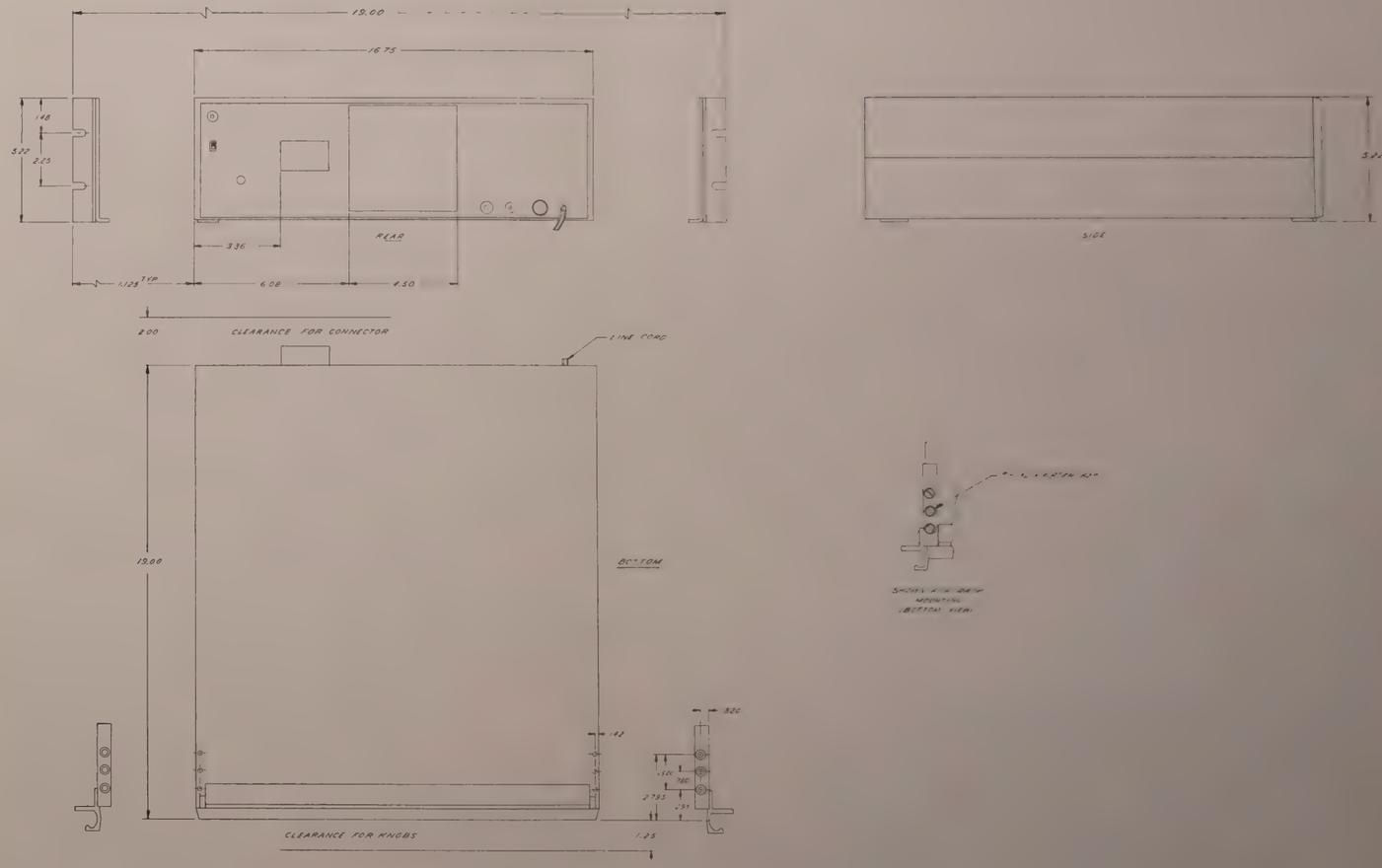
CAUTION

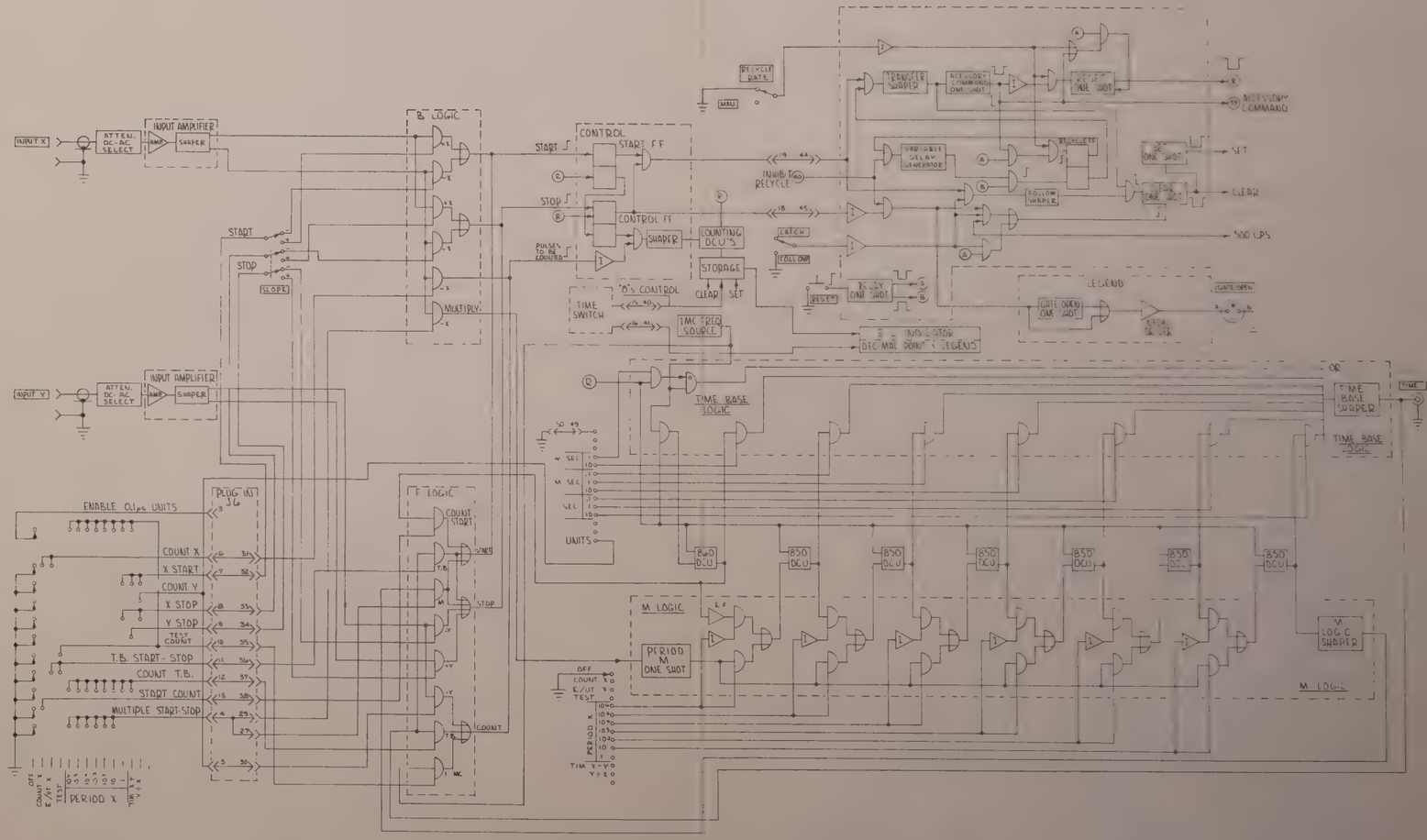
HIGH VOLTAGE: 900 v pp AND 90vDC ON POWER SUPPLY AND READOUT CIRCUITRY.
OSCILLATOR IS ON WHEN POWER CORD IS CONNECTED.
DISCONNECT POWER CORD BEFORE REMOVING REGULATOR BOARD.

MODEL 6144 COMPONENT BOARD LAYOUT

MISCELLANEOUS PARTS
(Model 6144 Outline Drawing)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
	241-824552	Fan Blade, 4-inch nylon	Howard, Inc. 218-152	1
	317-413693	Hinge, Handle	Beckman	2
	327-411656	Printed Circuit Board Holder	Beckman	8
	842-819209	Fan Motor	Howard, Inc. 1075-3202	1
	776-411321	Heat Sink	Beckman	1
	776-827328	Heat Sink	Augut 9015-1G1	1
	864-806361	Insulator, Transistor Mtg., Aluminum	Monadnock 294457	2
	330-413694	Handle, Cast	Beckman	1
	337-413108	Fan Guard	Beckman	1
	433-413055	Rear Panel	Beckman	1
	327-415619	P.C. Board Holder, Asm., Modification	Beckman	1
	327-414710	Modified P.C. Board Holder	Beckman	1
	349-414969	Tilt Foot	Beckman	1
	338-414685	Spring Clamp, Tilt Foot	Beckman	2
	348-414684	Detent Plate, Tilt Foot	Beckman	2
	349-414683	Locking Plate, Tilt Foot	Beckman	2
	302-413690	Spring Detent, Tilt Foot	Beckman	2
	125-415249	Hinge Pin, Tilt Foot	Beckman	2
	302-413692	Spring, Handle	Beckman	2
	327-413153	Bracket, Plug-In Conn.	Beckman	1
	405-413714	Pin Guide	Beckman	1
	662-414822	Cable, Digital Recorder	Beckman	1
	662-414804	Cable J7 Plug-In	Beckman	1
	010-414488	Heat Sink Assembly	Beckman	1
	132-824977	Clip, Retainer, Indicator Lamp	Eldema 10905-01	1
	664-812450	Cordset, Elect., Power, 3 Cond., Blk, 6 ft.	Beckman	1
	325-413171	Knob, Round, Skirted	Beckman	2
	325-413174	Knob, Round, Skirted, Concentric Base	Beckman	2
	325-415351	Knob, Power	Beckman	1
	325-415350	Knob, Attenuator	Beckman	2
	325-415335	Knob, Display	Beckman	1
	433-411659	Front Panel	Beckman	1
	783-807862	Ferrite Bead	Ferroxcube 56-590-65/3B	2
	349-413691	Retainer, Top Cover	Beckman	1
	405-415007	Right Guide, Top Cover	Beckman	1
	405-415006	Left Guide, Top Cover	Beckman	1
	297-413615	Top Cover	Beckman	1
	778-416305	Shield, Attenuator	Beckman	1
	716-413516	Reset Button	Beckman	1
	778-412944	E.L. Shield	Beckman	1
	297-413696	Bottom Dust Cover	Beckman	1
	887-422136	Safety Shield	Beckman	1
	327-409643	P.C. Board Support	Beckman	2
	430-415711	Chassis Oscillator	Beckman	1
	327-404468	Printed Circuit Board Support	Beckman	4
	855-415073	Power Supply Assembly	Beckman	1
	855-415114	Time Switch Assembly	Beckman	1


19.00
16.75
5.22
1.48
3.25
3.36
REAR
1.25 TYP
6.08
4.50
SIDE
2.00
CLEARANCE FOR CONNECTOR
LINE CORD
19.00
BOTTOM
.320
.142
.120
.780
2.795
.291
CLEARANCE FOR KNOBS
1.25


INPUT X
ATTEN. DC-AC SELECT
INPUT AMPLIFIER
AMP
SHAPER
START
STOP
SLOPE
MULTIPLY
B LOGIC
CONTROL
START FF
CONTROL FF
SHAPER
COUNTING DCU'S
STORAGE
CLEAR
SET
LATCH
FOLLOW
RECYCLE RATE
MANU
RECYCLE SHAPER
ADJUSTABLE DELAY GENERATOR
INHIBIT RECYCLE
PULSES TO BE COUNTED
TIME SWITCH
TMC REQ SOURCE
B's CONTROL
RESET
ONE SHOT
LEGEND
GATE OPEN
DECIMAL POINT LEGENDS
INPUT Y
PLUG IN
ENABLE O.P.s UNITS
COUNT X
X START
COUNT Y
X STOP
Y STOP
TEST COUNT
T.B. START - STOP
COUNT T.B.
START COUNT
MULTIPLE START-STOP
PERIOD X
F LOGIC
COUNT START
STOP
COUNT
TIME BASE LOGIC
TIME BASE SHAPER
UNITS
M LOGIC
PERIOD M ONE SHOT
M LOGIC SHAPER
500 CPS

J6 PIN ASSIGNMENTS

Pin No.	Connection*
1	XA26-K
2	--
3	S1D-1
4	S1A-6
5	S2A-13
6	S1A-13
7	S1E-3
8	S1A-3
9	S1A-4
10	S1A-12
11	S1E-12
12	S1C-4
13	S1C-14
14	--
15	S2K-11
16	S1H-3
17	--
18	XA28-P
19	XA28-E
20	XA1-P
21	XA1-M
22	XA1-F
23	XA1-D
24	--
25	XA5-E
26	XA18-H
27	XA26-8
28	S2A-11
29	XA18-L
30	XA17-P
31	XA18-P
32	S4
33	S3
34	S3
35	XA26-3
36	XA26-12
37	XA26-4
38	XA26-N
39	--
40	XA2B-J
41	S1F-1
42	XA28-L
43	XA33A-A
44	XA33A-E
45	XA32B-J
46	XA32B-K
47	XA32B-L
48	XA32B-M
49	S2A-1
50	XA26-15

*Amphenol 57-20500
50 Contact Connections
(672-824946)

J7 PIN ASSIGNMENTS

Pin No.	Connection*
1	--
2	--
3	S1-E Count
4	--
5	XA29-2
6	--
7	--
8	--
9	--
10	XA26-C
11	--
12	1 MHz High
13	1 MHz Low
14	--
15	+90V
16	--
17	--
18	--
19	117V ac
20	--
21	--
22	--
23	--
24	--
25	XA28-C
26	--
27	--
28	--
29	--
30	--
31	--
32	--
33	--
34	--
35	--
36	--
37	--
38	--
39	--
40	+10V
41	-15V
42	+15V
43	--
44	117V ac
45	XA28-M
46	XA28-N
47	--
48	Ground
49	--
50	Ground

*Amphenol 57-20500
50 Contact Connections
(672-824946)

J9 PIN ASSIGNMENTS

Pin No.	Connection*
1	XA12B-S
2	XA12B-P
3	XA12B-D
4	XA12B-A
5	XA10B-S
6	XA10B-P
7	XA10B-D
8	XA10B-A
9	XA8B-S
10	XA8B-P
11	XA8B-D
12	XA8B-A
13	XA6B-S
14	XA6B-P
15	XA6B-D
16	XA6B-A
17	XA4B-S
18	XA4B-P
19	XA4B-D
20	XA4B-A
21	XA2B-S
22	XA2B-P
23	XA2B-D
24	XA2B-A
25	XA14B-S
26	XA14B-P
27	XA14B-D
28	XA14B-A
29	--
30	--
31	--
32	Ground
33	XA16B-S
34	XA16B-P
35	Ground
36	XA16B-D
37	XA16B-A
38	XA2B-B (Gnd)
39	XA33A-P
40	XA33B-C

*Cannon DPX-40-34S
40 Contact Connections
(672-806833)

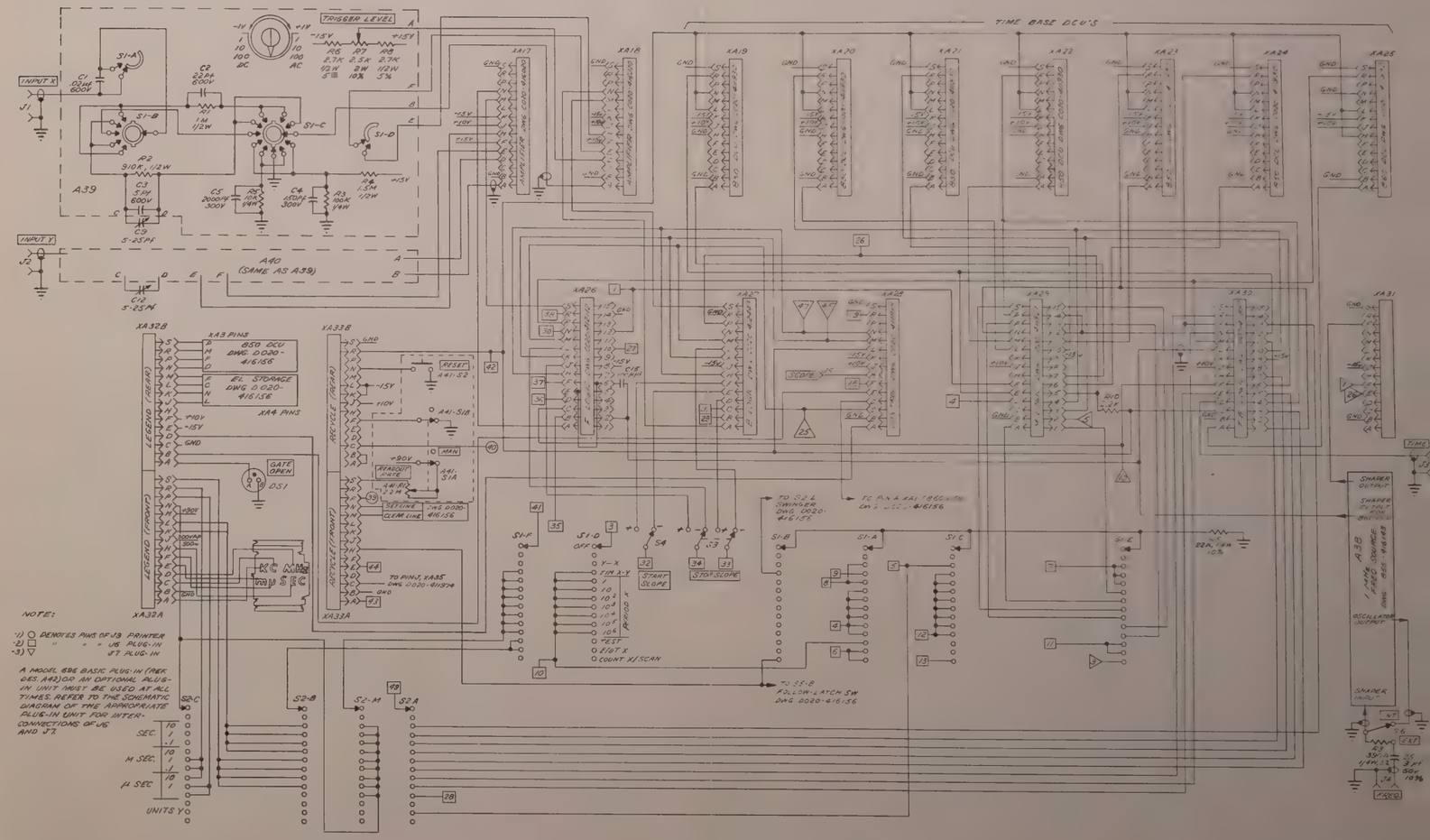
ATTENUATOR SWITCH ASSEMBLY (A39 & A40)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A39, 40	855-416144	Attenuator Switch Assembly	Beckman	2
C1	633-804722	Capacitor, F. Cerm., 0.02μf, 600V	Erie 817-.02	2
C2	633-804667	Capacitor, F. Cerm., 22pf, 600V	Centralab TCZ-22	2
C3	633-804657	Capacitor, F. Cerm., 5pf, 600V	Erie NPOK-050D	2
C4	637-824018	Capacitor, F. Mica, 150pf, 300V, 5%	Arco DM-16E151J-300	2
C5	637-824301	Capacitor, F. Mica, 2000pf, 300V, 5%	Arco DM-20F202J-300	2
R1	601-041151	Resistor, F. Comp., 1M, 1/2W, 5%	Allen Bradley EB1055	2
R2	601-008147	Resistor, F. Comp., 910K, 1/2W, 5%	Allen Bradley EB9145	2
R3	601-823904	Resistor, F. Comp., 100K, 1/4W, 5%	Allen Bradley CB1045	2
R4	601-013193	Resistor, F. Comp., 1.5M, 1/2W, 5%	Allen Bradley EB1555	2
R5	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	2
R6, R8	601-015045	Resistor, F. Comp., 2.7K, 1/2W, 5%	Allen Bradley EB2725	4
R7	614-414678	Resistor, V. Comp., 2.5K, ±10%	Beckman	2
S1	711-415565	Attenuator Switch	Beckman	2

MISCELLANEOUS PARTS
(Model 6144 Unit Logic)

A41	711-413778	Reset, Recycle Rate Assembly	Beckman	1
A41-R1	601-824831	Resistor, F. Comp., 2.2M, 1/4W, 10%	Allen Bradley CB2251	1
C5	639-835127	Capacitor, F. Cerm., 3μf, 50V, 10%	Elpac VX5A305	1
C9, 12	643-805005	Capacitor, V. Cerm., 5-25pf, 350V	Erie 557-F	2
C15	637-824016	Capacitor, F. Mica, 100pf, 300V, 5%	Electromotive DM16E101J-300	1
DS1	824-824973	Lamp, Neon, Plug-In Cartridge	Eldema CG3-CC-A1B	1
J1, 2, 3, 4	670-806738	Connector, Coaxial, Receptacle, BNC Type	Amphenol UG-1094/U	4
J5	683-817991	Jack, Banana, Red Nylon	Johnson 108-902	1
J6, 7	672-824946	Connector, Receptacle, 50 Female Contacts	Amphenol 57-20500	2
J9	672-806833	Connector, Receptacle, 40 Female Contacts	Cannon DPX-40-34S	1
R3	601-822371	Resistor, F. Comp., 390Ω, 1/4W, 5%	Allen Bradley CB3915	1
R10	601-812856	Resistor, F. Comp., 2.2K, 1/4W, 10%	Allen Bradley CB2221	1
S1	711-412989	Switch Spec. 14 Pos. 4 Sec. Type 7141R	Beckman P/O 50-414795	1
S2	711-413605	Switch Spec. 14 Pos. 7 Sec.	Beckman P/O 50-415114	1
S3	701-806040	Switch, Toggle, DPDT, 3A at 250V ac	Cutler Ham. 8373K8	1
S4	701-806039	Switch, Toggle, SPDT, 1A at 250V ac	Cutler Ham. 8282K13	1
S5	711-413785	Switch, Rotary, Oak Type F	Beckman	1
S6	716-827410	Switch, Slide, DPDT	Continental Type 126 (C-W)	1
XDS1	824-824974	Socket, Lamp Cartridge Mounting	Eldema #2K	1

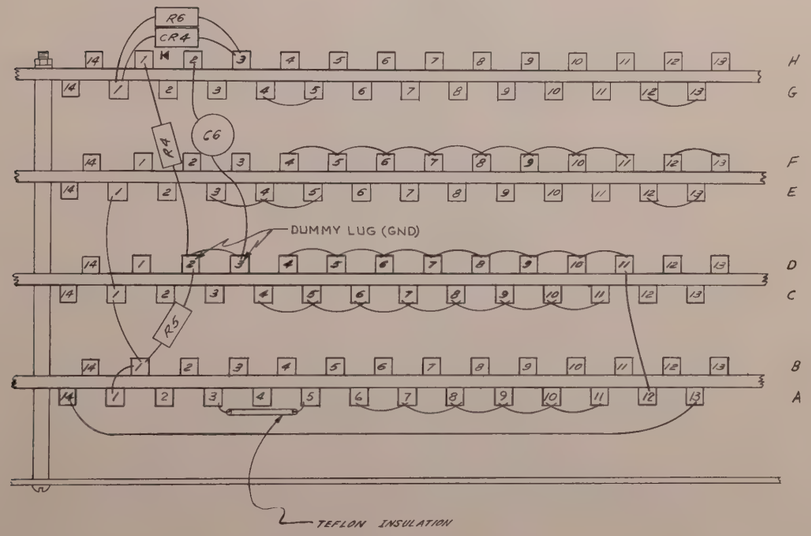
ATTENUATOR SWITCH ASSEMBLY, A39



Beckman®

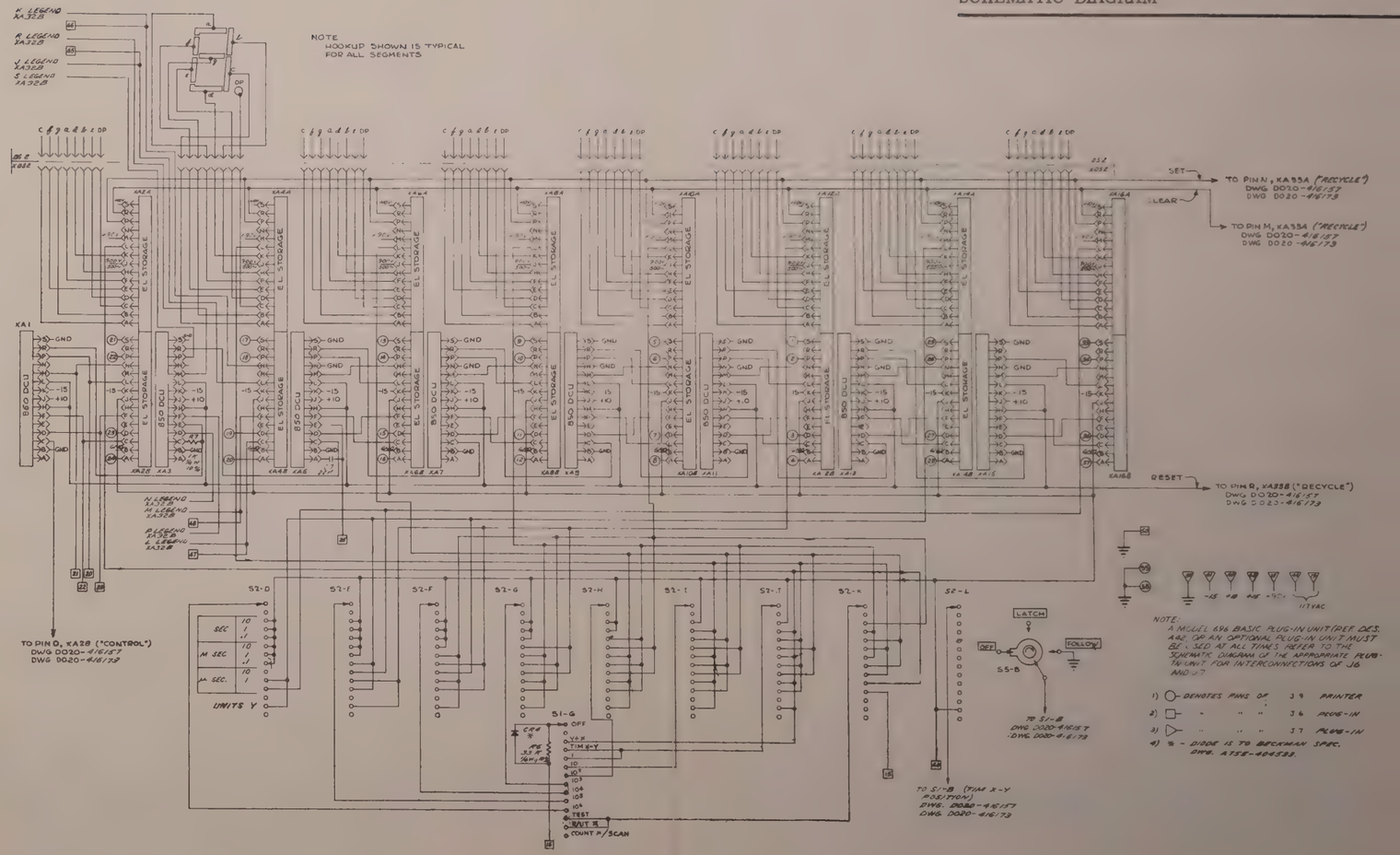
MISCELLANEOUS PARTS
(Model 6144 Count Logic)

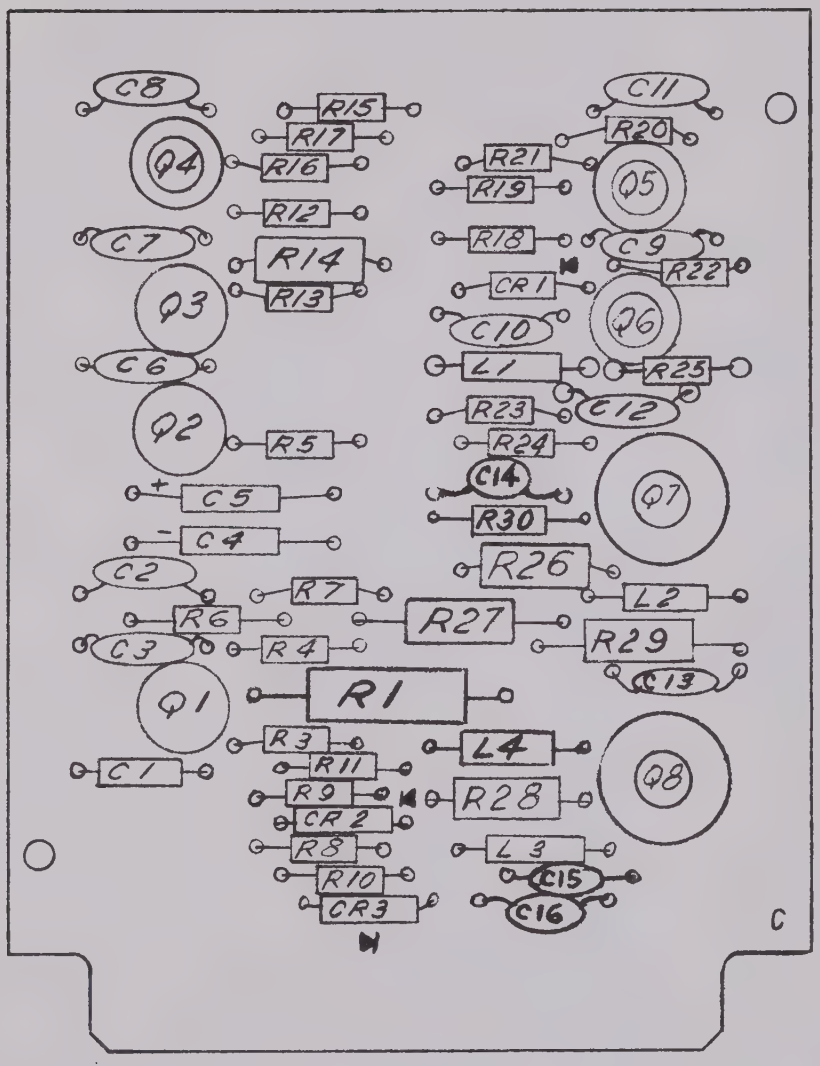
Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
C6	633-804717	Capacitor, F. Cerm., 0.01μf, 500V, 10%	Sprague 29C9B5	1
C7	637-824008	Capacitor, F. Mica, 22pf, 300V, 5%	Arco DM-16C220J-300	1
CR4	755-404593	Diode, Special	Beckman	1
DS2	823-412941	Readout, E. L., Eight Digit	Beckman	1
R4	601-823923	Resistor, F. Comp., 33Ω, 1/4W, 10%	Allen Bradley CB3301	1
R5	601-823921	Resistor, F. Comp., 22Ω, 1/4W, 10%	Allen Bradley CB2201	1
R6	601-823109	Resistor, F. Comp., 33K, 1/4W, 10%	Allen Bradley CB3301	1
R7	601-823111	Resistor, F. Comp., 1K, 1/4W, 10%	Allen Bradley CB1021	1
XDS2	697-412938	Socket, 8-Digit Electroluminescent Panel	Beckman	1



MODE SWITCH AND COMPONENT ASSEMBLY, S1
(Dwg. No. C414795 - A)

MODEL 6144
COUNT LOGIC
SCHEMATIC DIAGRAM





2.5 MHz INPUT AMPLIFIER
COMPONENT LAYOUT (A17 & A18)

2.5 MHz INPUT AMPLIFIER (A17 & A18)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A17 (Input Y) A18 (Input X)	887-410929	2.5 MHz Input Amplifier Board	Beckman	2
C1	637-824028	Capacitor, F. Mica, 1000pf, 300V, 5%	Elmenco DM16E102J-300	1
C2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	633-804717	Capacitor, F. Cerm., 0.01μf, 500V, -20, +80%	Sprague 29C9B5	13
C4, 5	631-824631	Capacitor, F. Elect., 10μf, 20V, 20%	Fansteel STA-621-1	2
CR1	755-819903	Diode, Zener, Silicon, 7V	Transistron 1N763-2	1
CR2, 3	755-815561	Diode, Silicon, 75 PIV, 10ma, 1V min. fwd.	Continental CD6111	2
L1	795-819899	Inductor, Fixed, R.F., 0.22μH	Delavan, 1840-02	1
L2, 3	795-819898	Inductor, Fixed, R.F., 0.47μH	Delavan 1840-06	2
L4	795-807878	Inductor, Fixed, R.F., 0.010mH	National NA-10-0-1	1
Q1, 3	755-409895	Transistor, Special	Beckman	2
Q2	755-817964	Transistor, Silicon, NPN, 600mW max.	P.S.I. 2N1420	1
Q4	755-817587	Transistor, Germ., PNP, 150mW max.	Motorola 2N968	1
Q5, 6	755-419596	Transistor, Special	Beckman	2
Q7, 8	755-817811	Transistor, Germ., PNP, 150mW	Motorola 2N961	2
R1	601-015449	Resistor, F. Comp., 1.8K, 1/2W, 5%	Allen Bradley EB1825	1
R2, 14	601-000897	Resistor, F. Comp., 2.2K, 1/2W, 5%	Allen Bradley EB2225	2
R3, 5	601-822297	Resistor, F. Comp., 4.7K, 1/4W, 5%	Allen Bradley CB4725	2
R4, 7, 15, 17, 21	601-823389	Resistor, F. Comp., 68Ω, 1/4W, 5%	Allen Bradley CB6805	5
R6	601-010942	Resistor, F. Comp., 6.8K, 1/2W, 5%	Allen Bradley EB6825	1
R8, 9	601-822798	Resistor, F. Comp., 68K, 1/4W, 5%	Allen Bradley CB6835	2
R10	601-823904	Resistor, F. Comp., 100K, 1/4W, 5%	Allen Bradley CB1045	1
R11	601-823905	Resistor, F. Comp., 120K, 1/4W, 5%	Allen Bradley CB1245	1
R12	601-822296	Resistor, F. Comp., 3.3K, 1/4W, 5%	Allen Bradley CB3325	1
R13, 20	601-822527	Resistor, F. Comp., 1.5K, 1/4W, 5%	Allen Bradley CB1525	2
R16	601-823397	Resistor, F. Comp., 5.6K, 1/4W, 5%	Allen Bradley CB5625	1
R18, 23	601-823379	Resistor, F. Comp., 10Ω, 1/4W, 5%	Allen Bradley CB1005	2

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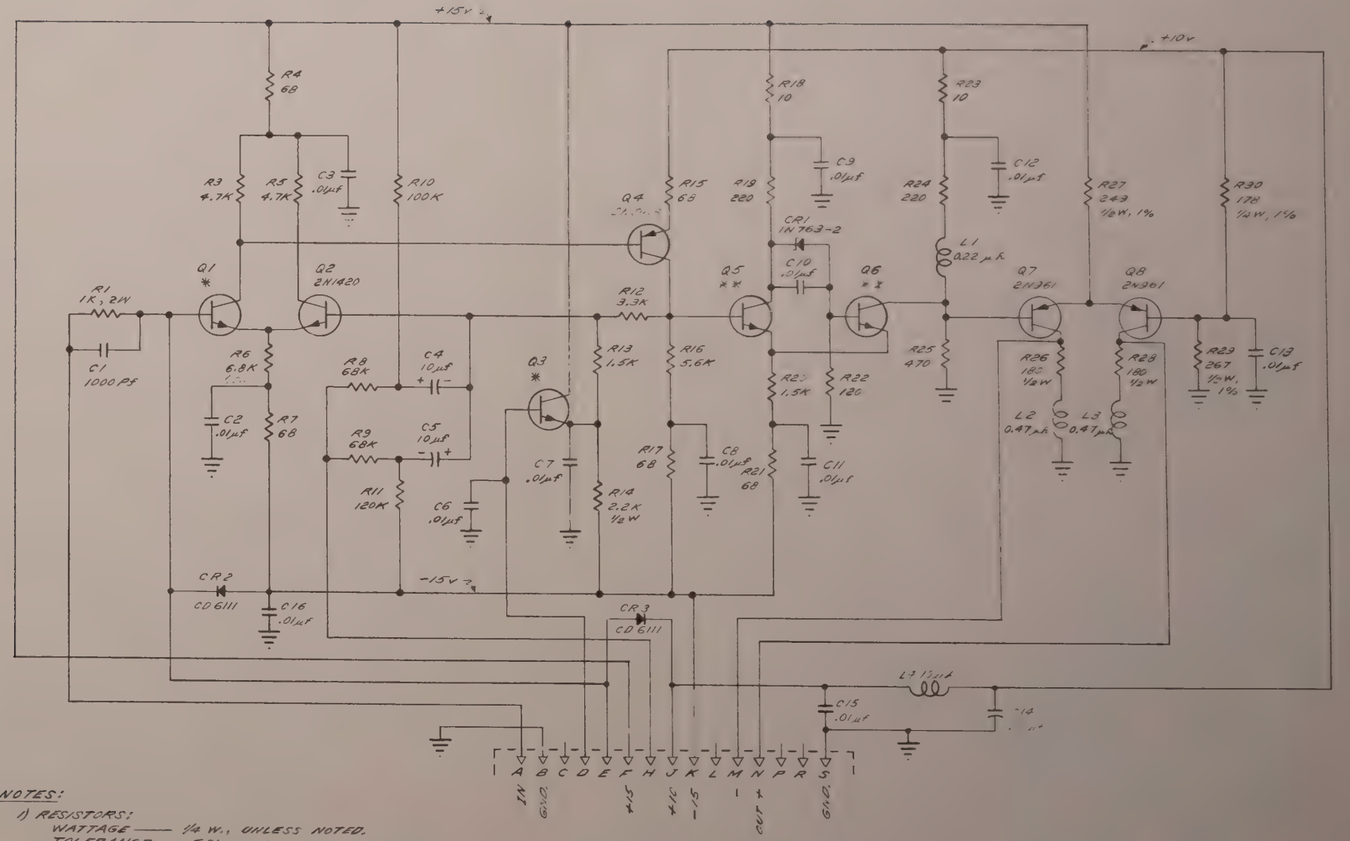
2.5MHz INPUT AMPLIFIER (A17 & A18) - continued

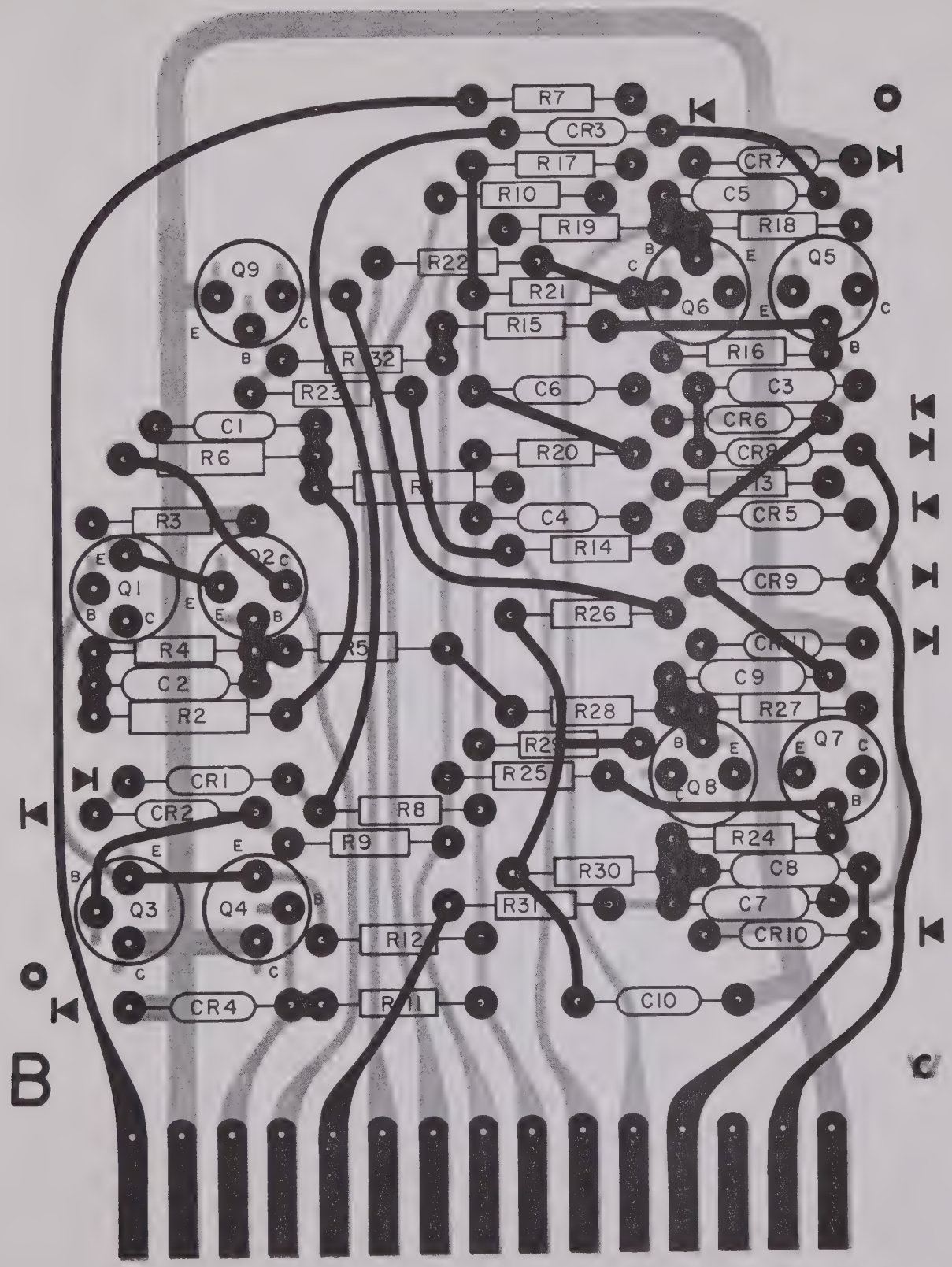
Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
R19, 24	601-822327	Resistor, F. Comp., 220Ω, 1/4W, 5%	Allen Bradley CB2215	2
R22	601-823390	Resistor, F. Comp., 120Ω, 1/4W, 5%	Allen Bradley CB1215	1
R25	601-823395	Resistor, F. Comp., 470Ω, 1/4W, 5%	Allen Bradley CB4715	1
R26, 28	601-024744	Resistor, F. Comp., 180Ω, 1/2W, 5%	Allen Bradley EB1815	2
R27	607-824997	Resistor, F. Film, 249Ω, 1/2W, 1%	Inter Res. MEB-T-2-249-1%	1
R29	607-824996	Resistor, F. Film, 267Ω, 1/2W, 1%	Inter Res. MEB-T-2-267-1%	1
R30	607-824998	Resistor, F. Film, 178Ω, 1/4W, 1%	Inter Res. MEA-T-2-178-1%	1
	776-827315	Heat Sink	Birtcher 3AL635-5GR	2
	864-412958	Pad, Converter, Transistor	Beckman	8



NOTES:
1) RESISTORS:
WATTAGE —— 1/4 W., UNLESS NOTED.
TOLERANCE — 5%, " " .
2) CAPACITORS:
Pf CAPACITORS ARE 300v., 5%, UNLESS NOTED.
3) .01µf DISCS ARE -20+80%, 500v.
4) * TRANSISTORS ARE TO BECKMAN SPEC. DWG. A755-409895.
5) ** TRANSISTORS ARE TO BECKMAN SPEC. DWG. A755-410596.

Model 6144
C416020 - Rev. G
March 1967

Beckman



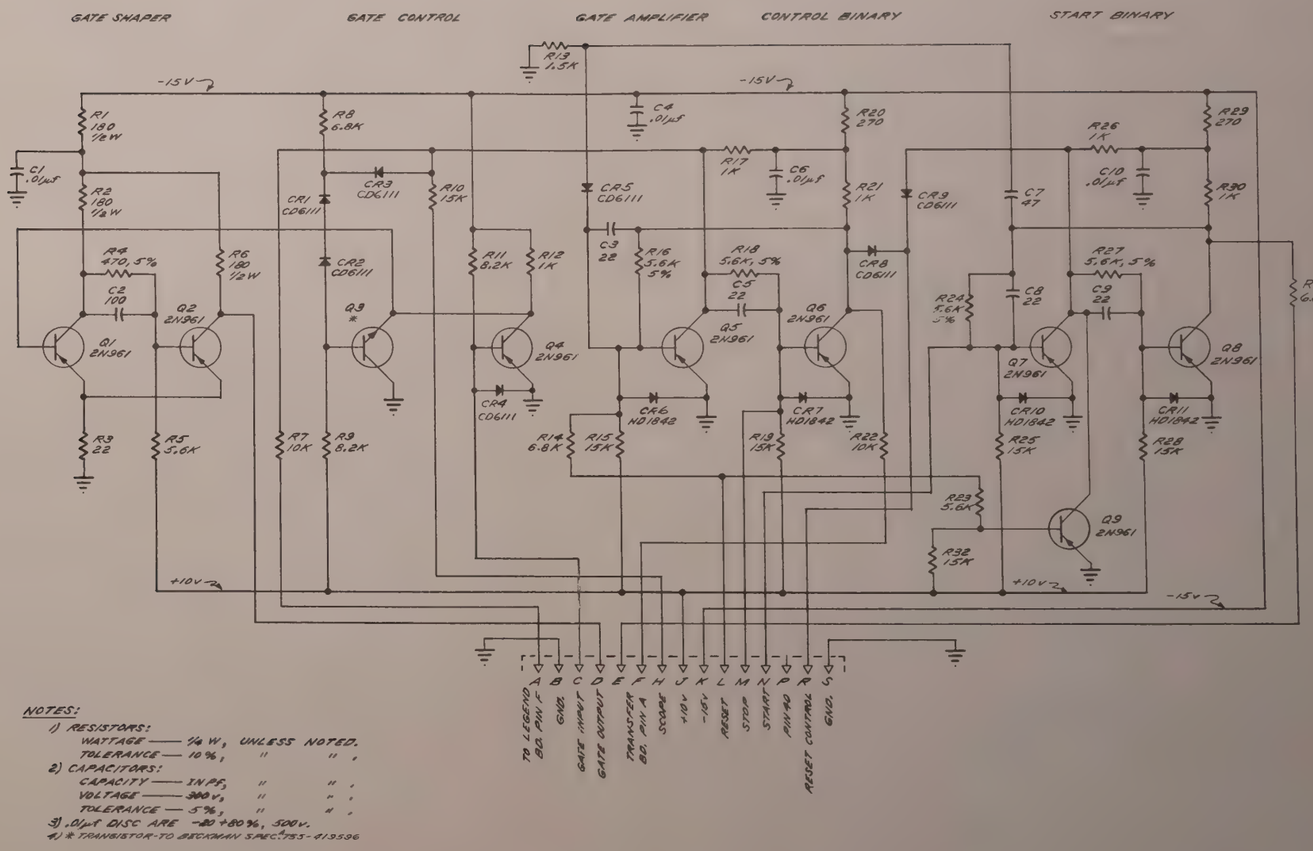
CONTROL COMPONENT LAYOUT (A28)

Model 6144
64A-6100-013-Rev. E
March 1967

Beckman®

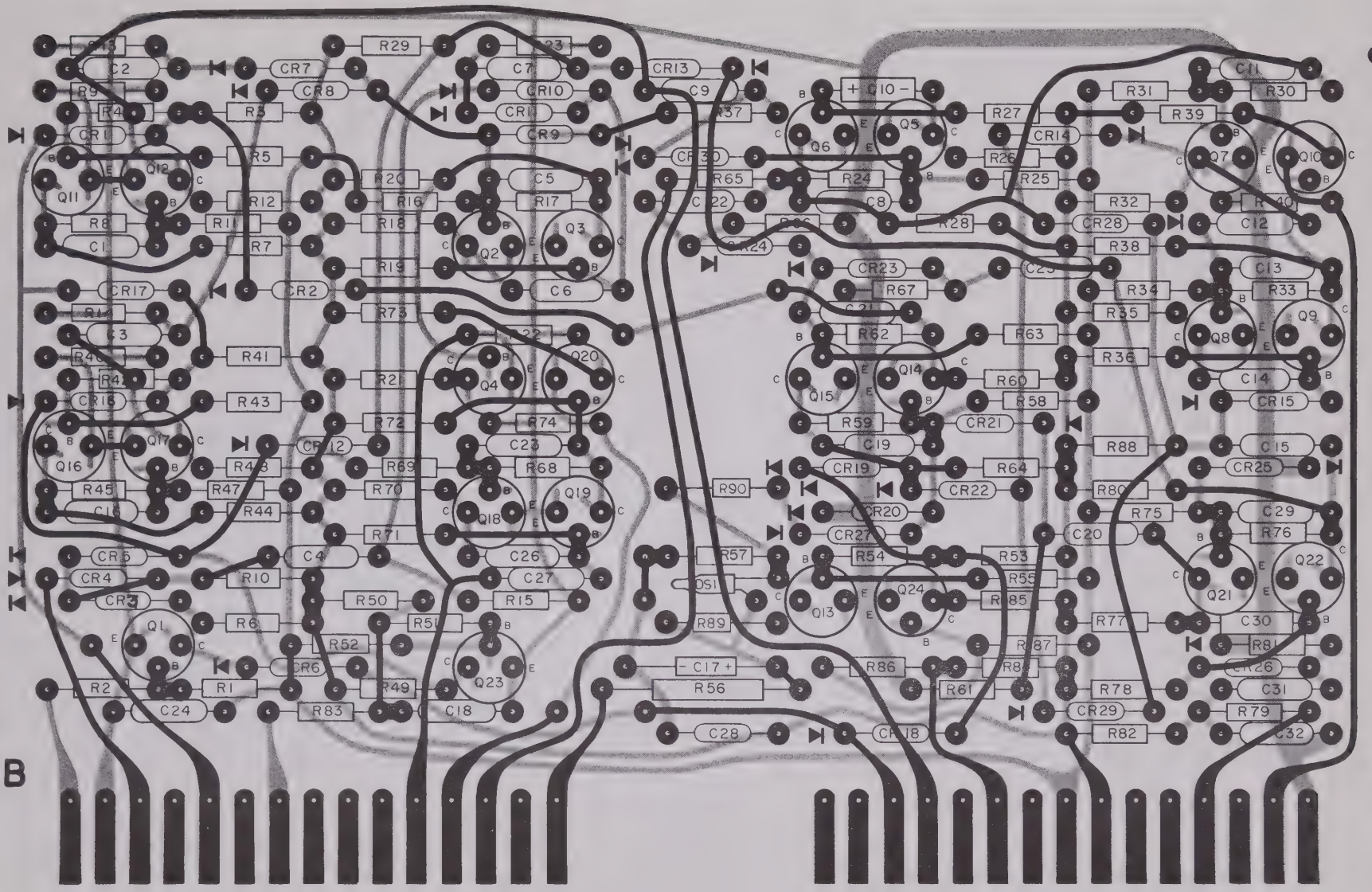
CONTROL BOARD (A28)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A28	887-410903	Control Board	Beckman	1
C1, 4, 6, 10	633-804717	Capacitor, F. Cerm., 0.01μf, 500V	Sprague 29C9B5	4
C2	637-824016	Capacitor, F. Mica, 100pf, 300V, 5%	Arco DM16E101J-300	1
C3, 5, 8, 9	637-824008	Capacitor F. Mica 22pf, 300V 5%	Arco DM16C220J-300	4
C7	637-824012	Capacitor, F. Mica, 47pf 300V, 5%	Arco DM16E470J-300	1
CR1, 2, 3, 4, 5, 8, 9	755-815561	Diode Silicon, 75PIV 10ma, 1V min. fwd.	Continental CD6111	7
CR6, 7, 10, 11	755-824300	Diode, Germanium	Hughes HD1842	4
Q1, 2, 4, 5, 6, 7, 8, 9	755-817811	Transistor, Germanium PNP 150mw	Motorola 2N961	8
Q3	755-419596	Transistor, Special	Beckman	1
R1, 2, 6	601-008068	Resistor, F. Comp., 180Ω, 1/2W, 10%	Allen Bradley EB1811	3
R3	601-823921	Resistor, F. Comp., 22Ω, 1/4W, 10%	Allen Bradley CB2201	1
R4	601-823395	Resistor, F. Comp., 470Ω, 1/4W, 5%	Allen Bradley CB4715	1
R5, 23	601-823944	Resistor, F. Comp., 5.6K, 1/4W, 10%	Allen Bradley CB5621	2
R7, 22	601-823108	Resistor, F. Comp., 10K, 1/4W, 10%	Allen Bradley CB1031	2
R8, 14, 31	601-823945	Resistor, F. Comp. 6.8K, 1/4W, 10%	Allen Bradley CB6821	3
R9, 11	601-823946	Resistor, F. Comp., 8.2K, 1/4W, 10%	Allen Bradley CB8221	2
R10, 15, 19, 25, 28, 32	601-823107	Resistor, F. Comp., 15K, 1/4W, 10%	Allen Bradley CB1531	6
R12, 17, 21, 26, 30	601-823111	Resistor, F. Comp., 1K, 1/4W, 10%	Allen Bradley CB1021	5
R13	601-823112	Resistor, F. Comp., 1.5K, 1/4W, 10%	Allen Bradley CB1521	1
R16, 18, 24, 27	601-822397	Resistor, F. Comp., 5.6K, 1/4W 5%	Allen Bradley CB5625	4
R20, 29	601-823934	Resistor, F. Comp., 270Ω, 1/4W, 10%	Allen Bradley CB2711	2
	864-412958	Pad, Transistor	Beckman	8



NOTES:

1) RESISTORS:
   WATTAGE —— ¼ W, UNLESS NOTED.
   TOLERANCE —— 10%, " "
2) CAPACITORS:
   CAPACITY —— IN PF, " "
   VOLTAGE —— 300 V, " "
   TOLERANCE —— 5%, " "
3) .01μf DISC ARE -20 +80%, 500v.
4) * TRANSISTOR-TO BECKMAN SPEC. 133-413596



RECYCLE COMPONENT LAYOUT (A33)

Model 6144
64C-6100-024-Rev. J
March 1967

RECYCLE BOARD (A33)

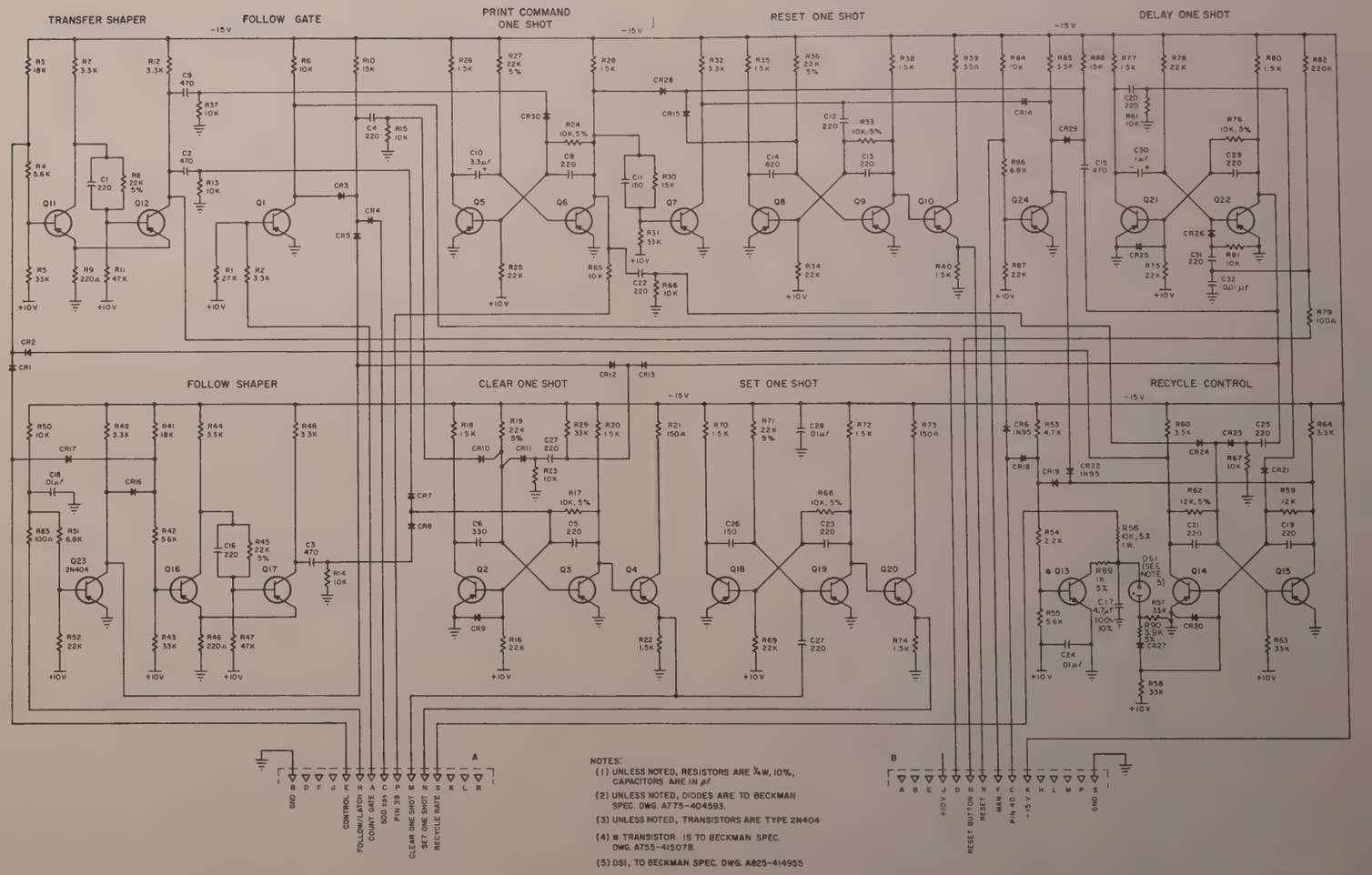
Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A33	887-411673	Recycle Board	Beckman	1
C1, 4, 5, 7, 8, 12, 13, 16, 19, 20, 21, 22, 23, 25, 27, 29, 31	637-824020	Capacitor, F. Mica, 220pf,	Arco DM16E221J-300	17
C2, 3, 9, 15	637-824024	Capacitor, F. Mica, 470pf, 300V, 5%	Arco DM16E471J-300	4
C6	637-824022	Capacitor, F. Mica, 330pf, 300V, 5%	Arco DM16E331J-300	1
C10	631-819463	Capacitor, F. Elect., 3.3μf, 15V, 10%	Fansteel STA5123-1	1
C11, 26	637-824018	Capacitor, F. Mica, 150pf, 300V, 5%	Arco DM16E151J-300	2
C14	637-824027	Capacitor, F. Mica, 820pf, 300V, 5%	Arco DM16E821J-300	1
C17	631-828102	Capacitor, F. Elect., 4.7μf, 100V	Fansteel SP120-11	1
C18, 24, 28, 32	633-804717	Capacitor, F. Cerm., 0.01μf, 500V	Sprague 29C9B5	4
C30	631-814053	Capacitor, F. Elect., 1μf, 35V, 20%	Sprague 150D105X0035A2	1
CR1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30	755-404593	Diode, Special	Beckman	27
CR6, 14, 22	755-402107	Diode, Special	Beckman	3
DS1	825-414955	Lamp, Neon, Special	Beckman	1
Q1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24	755-800398	Transistor, Germ., PNP, 150mW max.	Sylvania 2N404	23
Q13	755-415078	Transistor, Special	Beckman	1
R1	601-823949	Resistor, F. Comp., 27K, 1/4W, 10%	Allen Bradley CB2731	1
R2, 7, 12, 32, 44, 48, 49, 60, 64, 85	601-823942	Resistor, F. Comp., 3.3K, 1/4W, 10%	Allen Bradley CB3321	10
R3, 41	601-823948	Resistor, F. Comp., 18K, 1/4W, 10%	Allen Bradley CB1821	2
R4, 42	601-823944	Resistor, F. Comp., 5.6K, 1/4W, 10%	Allen Bradley CB5621	2
R5, 29, 31, 43, 57, 58, 63	601-823109	Resistor, F. Comp., 33K, 1/4W, 10%	Allen Bradley CB3331	7
R6, 13, 14, 15, 23, 37, 50, 61, 65, 66, 67, 81, 84	601-823108	Resistor, F. Comp., 10K,	Allen Bradley CB1031	13
R8, 19, 27, 36, 45, 71	601-822334	Resistor, F. Comp., 22K, 1/4W, 5%	Allen Bradley CB2235	6
R9, 46	601-823933	Resistor, F. Comp., 220Ω,	Allen Bradley CB2211	2

. . . continued

RECYCLE BOARD (A33) - continued

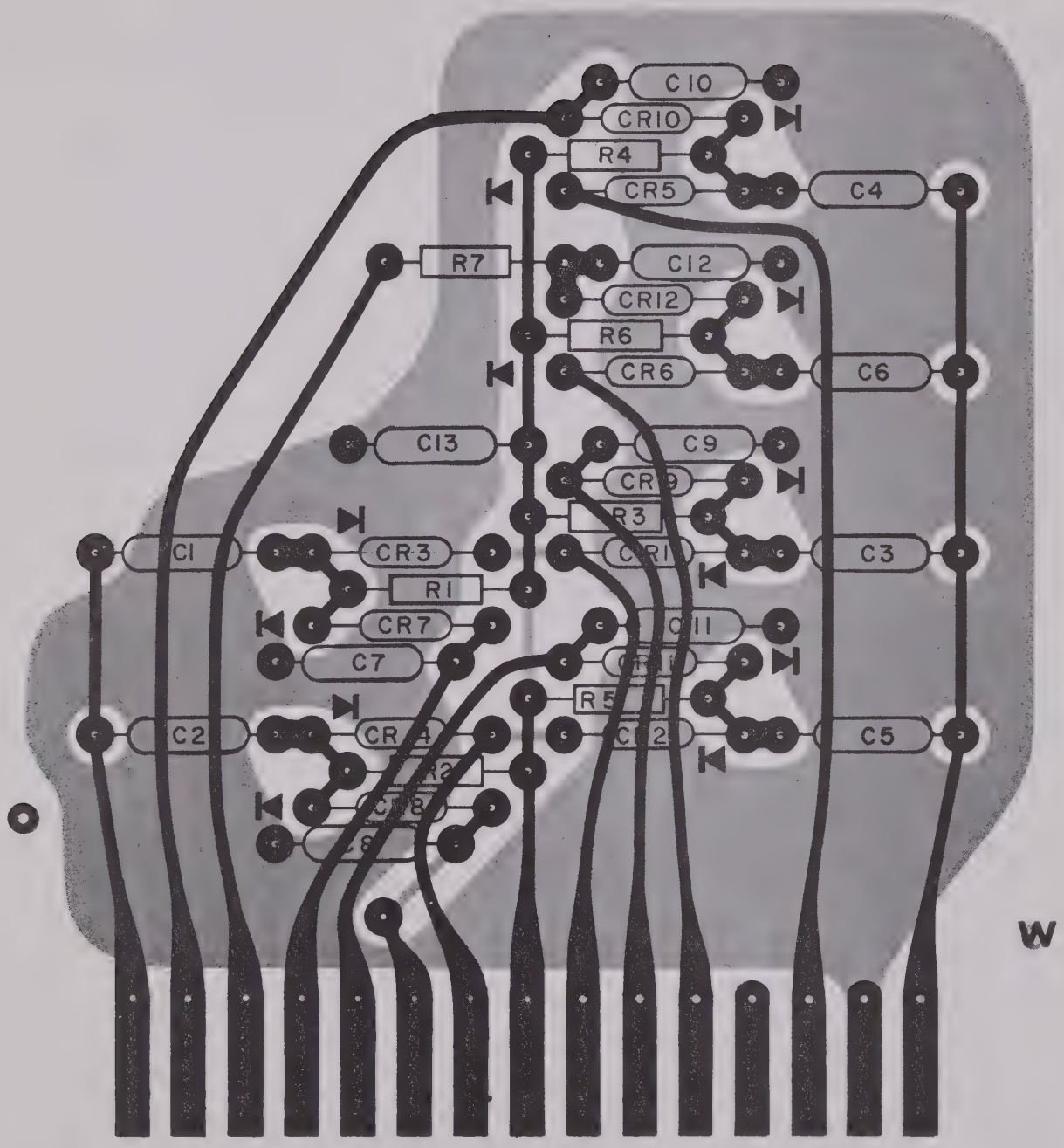
Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
R10, 30, 88	601-823107	Resistor, F. Comp., 15K, 1/4W, 10%	Allen Bradley CB1531	3
R11, 47	601-823951	Resistor, F. Comp., 47K, 1/4W, 10%	Allen Bradley CB4731	2
R16, 25, 34, 52, 69, 75, 78, 87	601-823110	Resistor, F. Comp., 22K, 1/4W, 10%	Allen Bradley CB2231	8
R17, 24, 33, 68, 76	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	5
R18, 20, 22, 26, 28, 35, 38, 40, 70, 72, 74, 77, 80	601-823112	Resistor, F. Comp., 1.5K, 1/4W, 10%	Allen Bradley CB1521	13
R21, 73	601-823931	Resistor, F. Comp., 150Ω, 1/4W, 10%	Allen Bradley CB1511	2
R39	601-823923	Resistor, F. Comp., 33Ω, 1/4W, 10%	Allen Bradley CB3301	1
R51, 86	601-823945	Resistor, F. Comp., 6.8K, 1/4W, 10%	Allen Bradley CB6821	2
R53	601-815239	Resistor, F. Comp., 4.7K, 1/4W, 10%	Allen Bradley CB4721	1
R54	601-812856	Resistor, F. Comp., 2.2K, 1/4W, 10%	Allen Bradley CB2221	1
R55	601-823944	Resistor, F. Comp., 5.6K, 1/4W, 5%	Allen Bradley CB5625	1
R56	601-043209	Resistor, F. Comp., 10K, 1W, 5%	Allen Bradley GB1035	1
R59	601-823947	Resistor, F. Comp., 12K, 1/4W, 10%	Allen Bradley CB1231	1
R62	601-822333	Resistor, F. Comp., 12K, 1/4W, 5%	Allen Bradley CB1235	1
R79, 83	601-823929	Resistor, F. Comp., 100Ω, 1/4W, 10%	Allen Bradley CB1011	2
R82	601-812742	Resistor, F. Comp., 220K, 1/4W, 10%	Allen Bradley CB2241	1
R89	601-822308	Resistor, F. Comp., 1K, 1/4W, 5%	Allen Bradley CB1025	1
R90	601-823943	Resistor, F. Comp., 3.9K, 1/4W, 10%	Allen Bradley CB3925	1
	864-412958	Pad, Transistor	Beckman	24

RECYCLE (A33)
SCHEMATIC DIAGRAM


TRANSFER SHAPER
FOLLOW GATE
PRINT COMMAND ONE SHOT
RESET ONE SHOT
DELAY ONE SHOT
FOLLOW SHAPER
CLEAR ONE SHOT
SET ONE SHOT
RECYCLE CONTROL
-15 V
+10V
NOTES:
(1) UNLESS NOTED, RESISTORS ARE ¼W, 10%, CAPACITORS ARE IN μf.
(2) UNLESS NOTED, DIODES ARE TO BECKMAN SPEC. DWG. A775-404593.
(3) UNLESS NOTED, TRANSISTORS ARE TYPE 2N404
(4) ■ TRANSISTOR IS TO BECKMAN SPEC. DWG. A755-415078.
(5) DSI, TO BECKMAN SPEC. DWG. A825-414955

Model 6144
64D-6100-025-Rev. J
March 1967

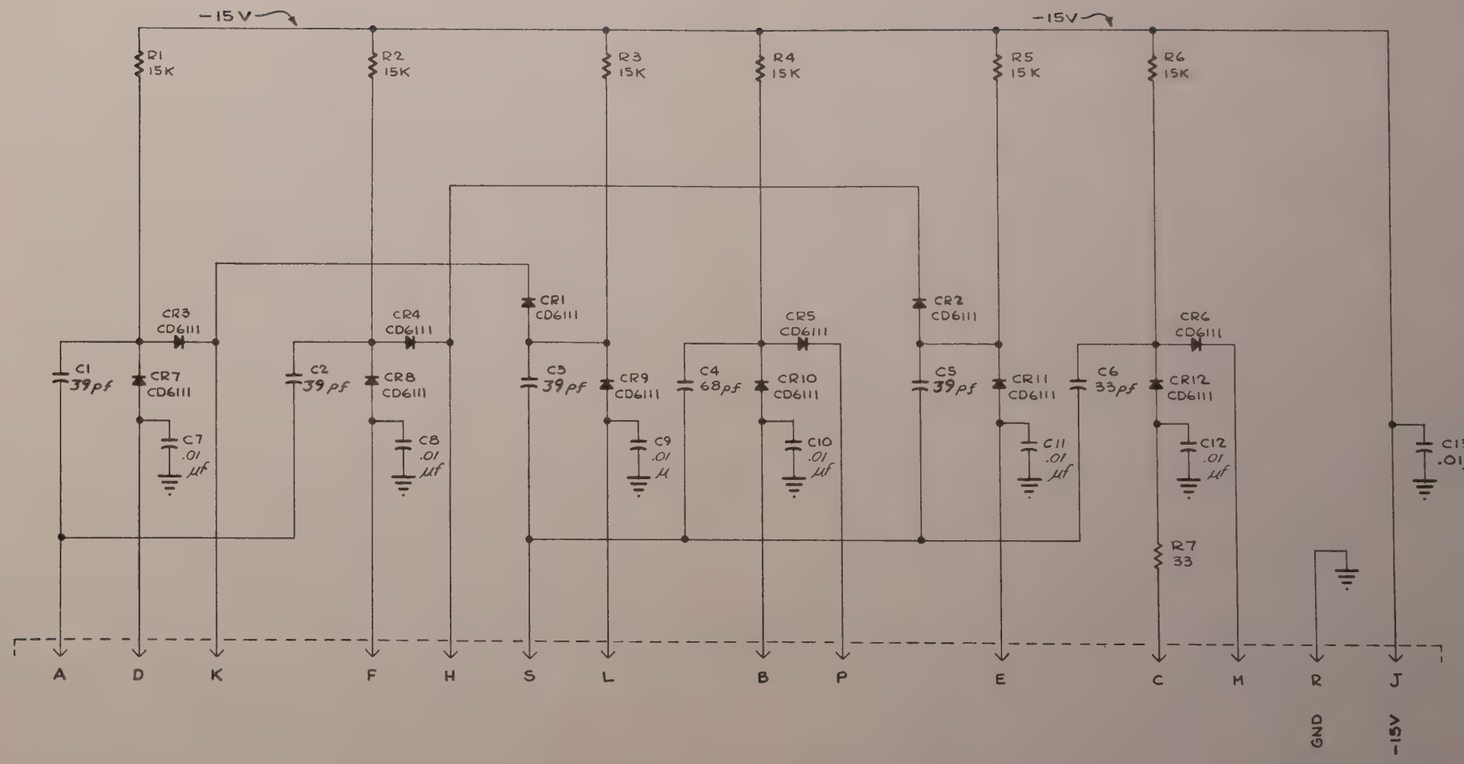
Beckman®



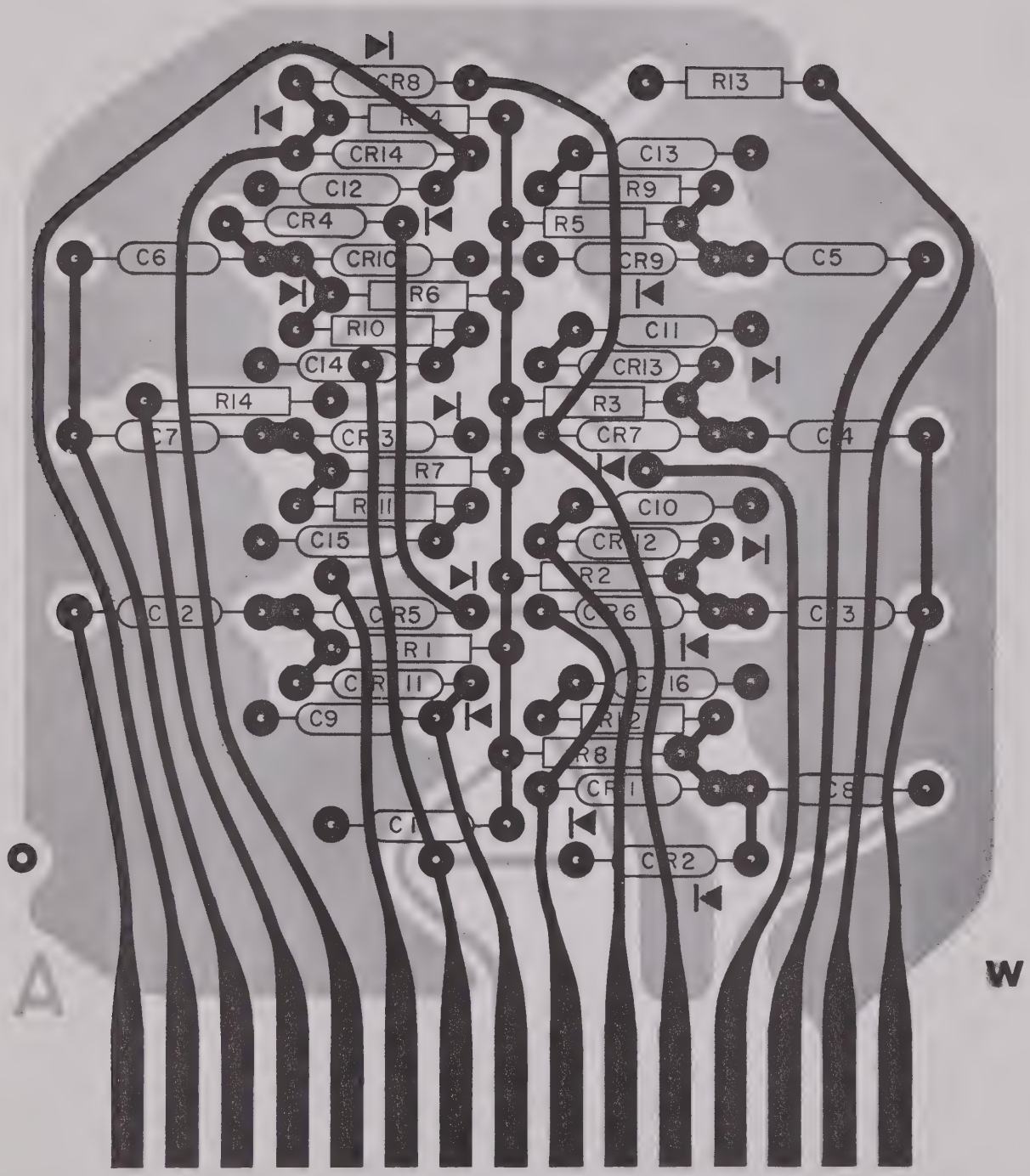
B LOGIC COMPONENT LAYOUT (A27)

B LOGIC BOARD (A27)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A27	887-412559	B Logic Board	Beckman	1
C1, 2, 3, 5	637-824011	Capacitor, F. Mica, 39pf, 300V, 5%	Arco DM16C390J-300	4
C4	637-824014	Capacitor, F. Mica, 68pf, 300V, 5%	Arco DM16E680J-300	1
C6	633-824010	Capacitor, F. Cerm., 33pf, 300V, 5%	Arco DM16E330J-300	1
C7, 8, 9, 10, 11, 12, 13	633-804717	Capacitor, F. Cerm., 0.01μf, 500V	Sprague 29C9B5	7
CR1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	755-815561	Diode, Silicon, 75PIV, 10ma, 1V min. fwd.	Continental CD6111	12
R1, 2, 3, 4, 5, 6	601-823107	Resistor, F. Comp., 15K, 1/4W, 10%	Allen Bradley CB1531	6
R7	601-823923	Resistor, F. Comp., 33Ω, 1/4W, 10%	Allen Bradley CB3301	1



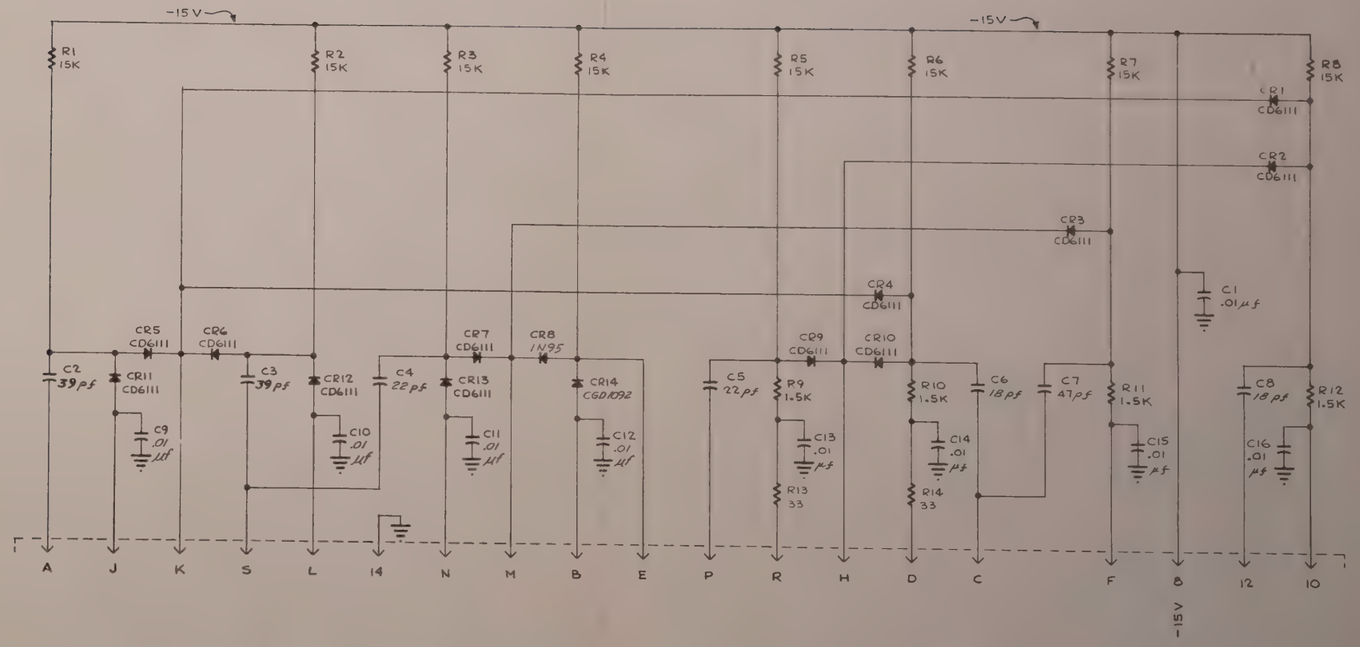
NOTE:
RESISTORS:
WATTAGE — 1/4 W, UNLESS NOTED.
TOLERANCE — 10%, " "
CAPACITORS:
VOLTAGE — 300v, " "
TOLERANCE — 5%, " "
.01 µf DISCS ARE -20 +80%, 500 V



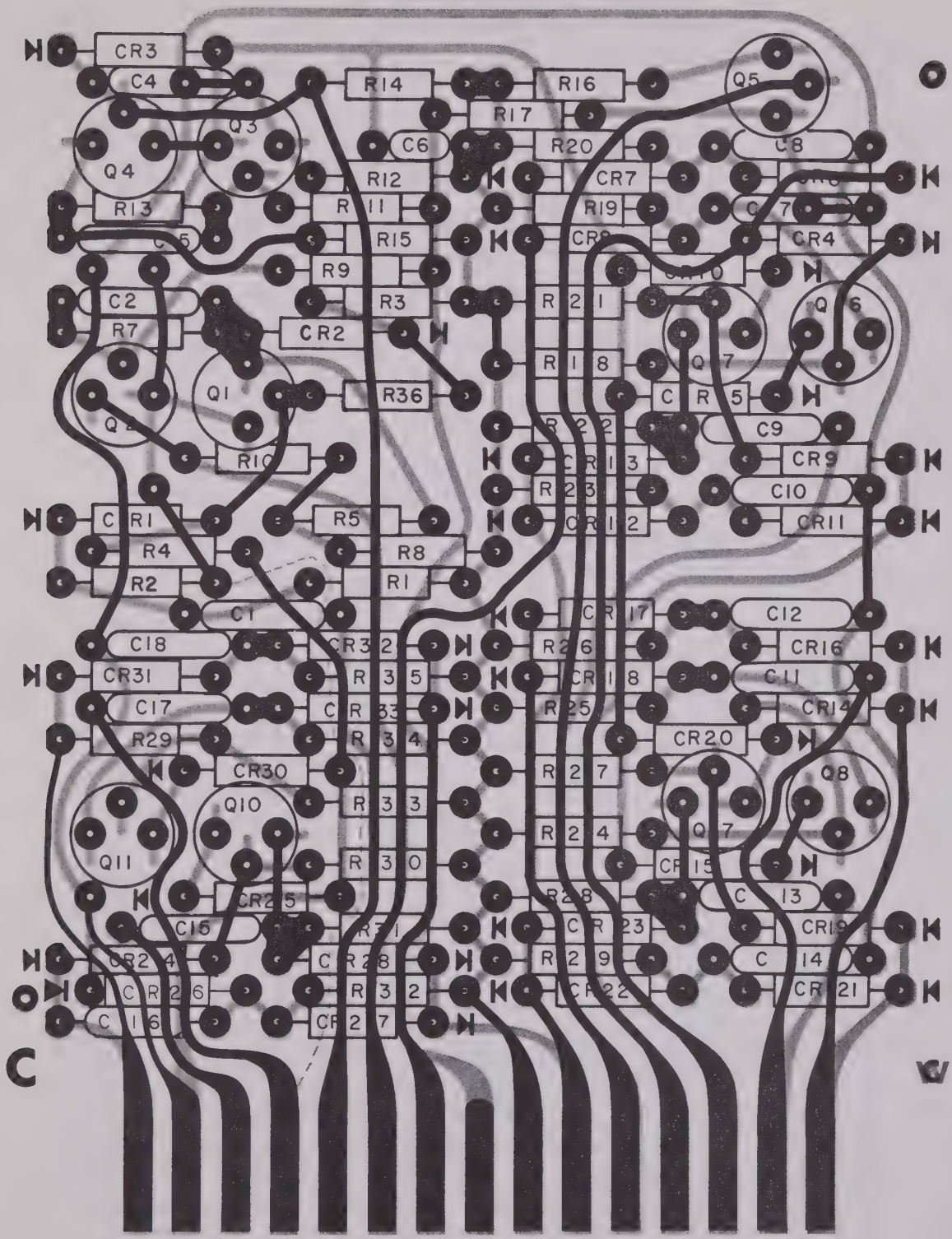
F LOGIC COMPONENT LAYOUT (A26)

F LOGIC BOARD (A26)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A26	887-412126	F Logic Board	Beckman	1
C1, 9, 10, 11, 12, 13, 14, 15, 16	633-804717	Capacitor, F. Cerm., 0.01μf, 500V	Sprague 29C9B5	9
C2, 3	637-824011	Capacitor, F. Mica, 39pf, 300V, 5%	Arco DM16C390J-300	2
C4, 5	637-824008	Capacitor, F. Mica, 22pf, 300V, 5%	Arco DM16E220J-300	2
C6, 8	637-824007	Capacitor, F. Mica, 18pf, 300V, 5%	Arco DM16C180J-300	2
C7	637-824012	Capacitor, F. Mica, 47pf, 300V, 5%	Arco DM16E470J-300	1
CR1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13	755-815561	Diode, Silicon, 75PIV, 10ma, 1V min. fwd.	Continental CD6111	12
CR8	755-402107	Diode, Special	Beckman	1
CR14	755-817812	Diode, Germ., 15PIV, 100ma, 1V min. fwd.	Clevite CGD-1092	1
R1, 2, 3, 4, 5, 6, 7, 8	601-823107	Resistor, F. Comp., 15K, 1/4W, 10%	Allen Bradley CB1531	8
R9, 10, 11, 12	601-823112	Resistor, F. Comp., 1.5K, 1/4W, 10%	Allen Bradley CB1521	4
R13, 14	601-823923	Resistor, F. Comp., 33Ω, 1/4W, 10%	Allen Bradley CB3301	2



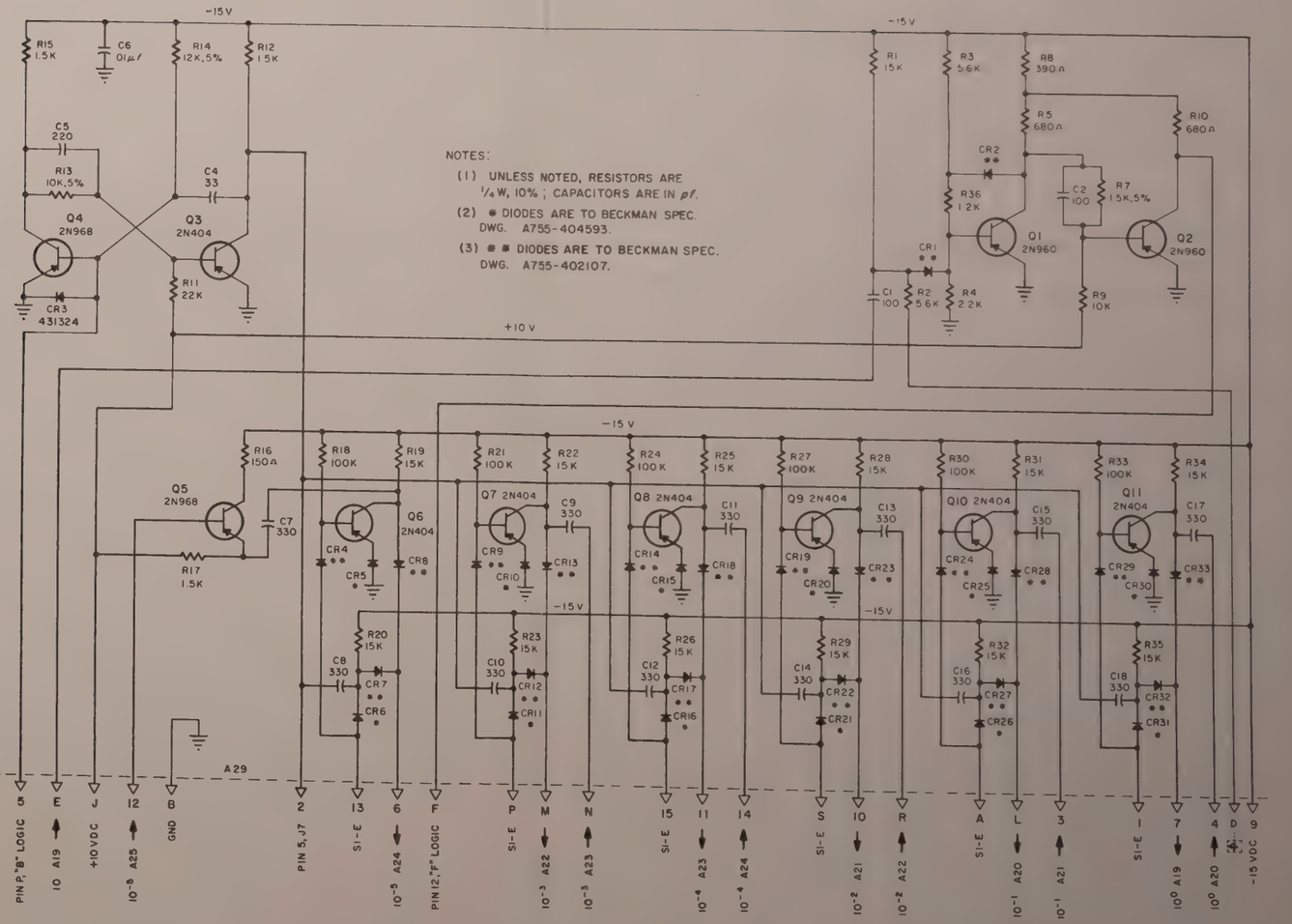
NOTE:
1) RESISTORS:
WATTAGE — 1/4 W, UNLESS NOTED
TOLERANCE — 10%, " "
2) CAPACITORS:
CAPACITY — IN PF, " "
VOLTAGE — 300 V, " "
TOLERANCE — 5%, " "
3) .01µf DISC ARE -20+80%, 500V



M LOGIC COMPONENT LAYOUT (A29)

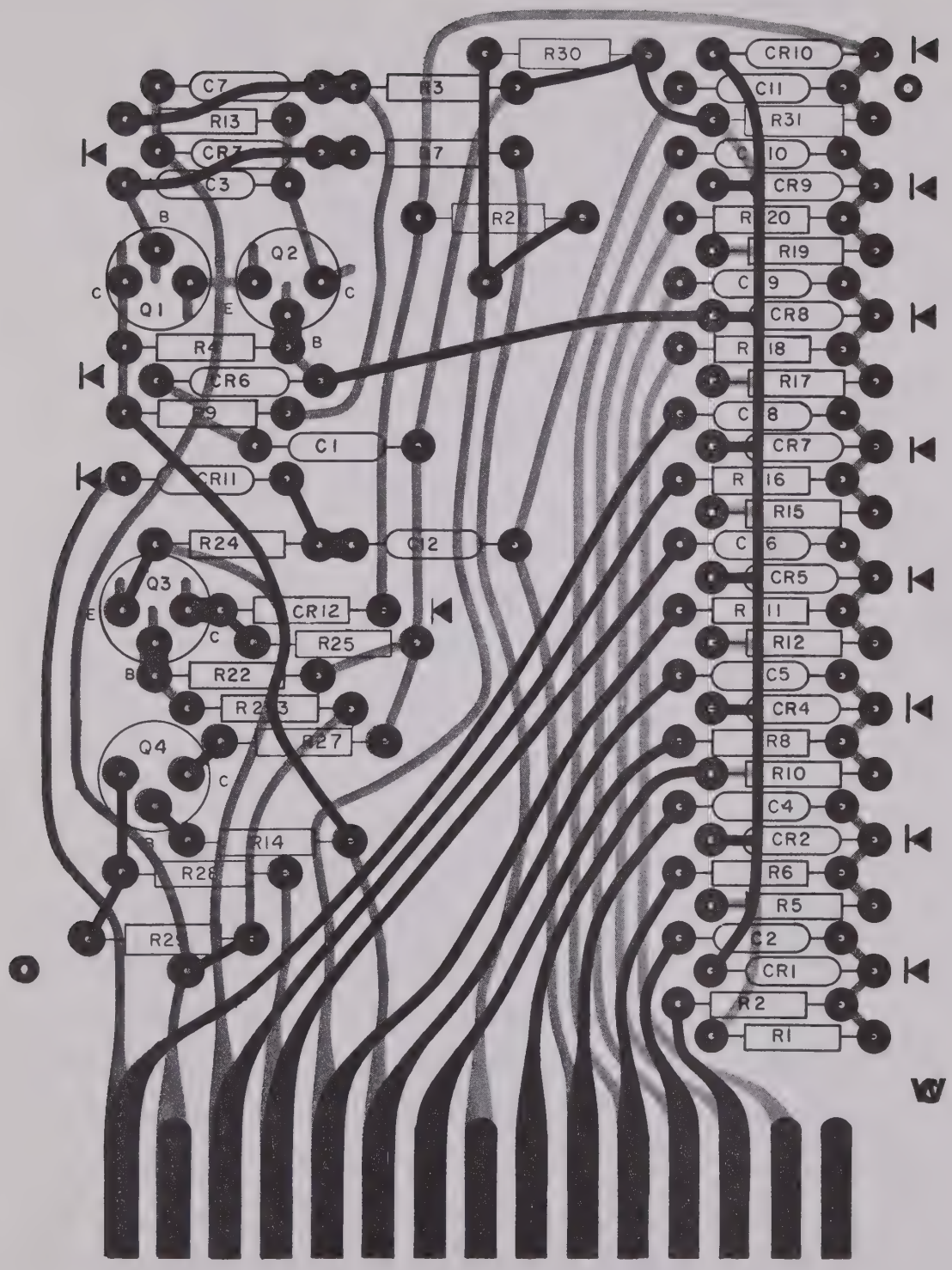
M LOGIC BOARD (A29)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A29	887-416904	M Logic Board	Beckman	1
C1, 2	637-824016	Capacitor, F. Mica, 100pf, 300V, 5%	Arco DM16E101J-300	2
C4	637-824010	Capacitor, F. Mica, 33pf, 300V, 5%	Arco DM16E330J-300	1
C5	637-824020	Capacitor, F. Mica, 220pf, 300V, 5%	Arco DM16E221J-300	1
C6	633-804715	Capacitor, F. Cerm., 0.01μf, 50V	Sprague 19C214	1
C7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18	637-824022	Capacitor, F. Mica, 330pf, 300V, 5%	Arco DM16E331J-300	11
C16	637-822908	Capacitor, F. Mica, 330pf, 500V, 5%	Electromotive DM15C-331J-500	1
CR1, 2, 4, 7, 8, 9, 12, 13, 14, 17, 18, 19, 22, 23, 24, 27, 28, 29, 32, 33	755-402107	Diode, Special	Beckman	20
CR3	755-431324	Diode, Special	Beckman	1
CR5, 6, 10, 11, 15, 16, 20, 21, 25, 26, 30, 31	755-404593	Diode, Special	Beckman	12
Q1, 2	755-824880	Transistor, Germanium, PNP, 150mw	Motorola 2N960	2
Q3, 6, 7, 8, 9, 10, 11	755-800398	Transistor, Germanium, PNP, 150mw max.	Sylvania 2N404	7
Q4, 5	755-817587	Transistor, Germanium, PNP, 150mw	Motorola 2N968	2
R1, 19, 20, 22, 23, 25, 26, 28, 29, 31, 32, 34, 35	601-823107	Resistor, F. Comp., 15K, 1/4W, 10%	Allen Bradley CB1531	13
R2, 3	601-823944	Resistor, F. Comp., 5.6K, 1/4W, 10%	Allen Bradley CB5621	2
R4	601-812856	Resistor, F. Comp., 2.2K, 1/4W, 10%	Allen Bradley CB2221	1
R5, 10	601-823937	Resistor, F. Comp., 680Ω, 1/4W, 10%	Allen Bradley CB6811	2
R7	601-822527	Resistor, F. Comp., 1.5K, 1/4W, 5%	Allen Bradley CB1525	1
R8	601-822371	Resistor, F. Comp., 390Ω, 1/4W, 5%	Allen Bradley CB3915	1
R9	601-823108	Resistor, F. Comp., 10K, 1/4W, 10%	Allen Bradley CB1525	1
R11	601-823110	Resistor, F. Comp., 22K, 1/4W, 10%	Allen Bradley CB2231	1
R12, 15, 17	601-823112	Resistor, F. Comp., 1.5K, 1/4W, 10%	Allen Bradley CB1521	3
R13	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	1
R14	601-822333	Resistor, F. Comp., 12K, 1/4W, 5%	Allen Bradley CB1235	1
R16	601-823931	Resistor, 150Ω, 1/4W, 10%	Allen Bradley CB1511	1
R18, 21, 24, 27, 30, 33	601-812741	Resistor, F. Comp., 100K, 1/4W, 10%	Allen Bradley CB1041	6
R36	601-823939	Resistor, F. Comp., 1.2K, 1/4W, 10%	Allen Bradley CB1221	1
	864-412958	Pad, Transistor	Beckman	11



Model 6144
64C-8100-029-Rev. F
March 1967

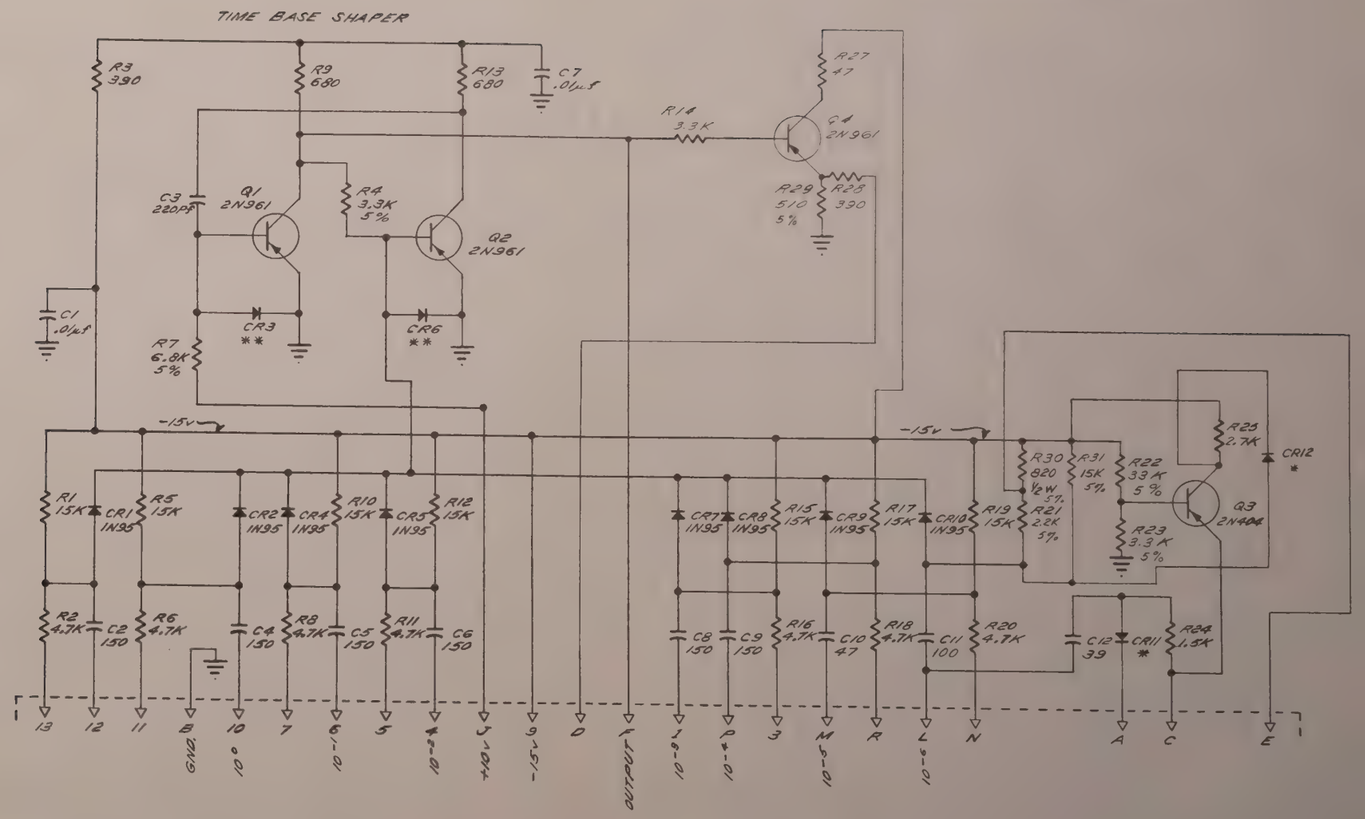
Beckman



TIME BASE LOGIC COMPONENT LAYOUT (A30)

TIME BASE LOGIC BOARD (A30)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty. / Ass'y
A30	887-411674	Time Base Logic Board	Beckman	1
C1, 7	633-804717	Capacitor, F. Cerm., 0.01μf, 500V	Sprague 29C9B5	2
C2, 4, 5, 6, 8, 9	637-824018	Capacitor, F. Mica, 150pf, 300V, 5%	Arco DM16E151J-300	6
C3	637-824020	Capacitor, F. Mica, 220pf, 300V, 5%	Arco DM16E221J-300	1
C10	637-824012	Capacitor, F. Mica, 47pf, 300V, 5%	Arco DM16E470J-300	1
C11	637-824016	Capacitor, F. Mica, 100pf, 300V, 5%	Arco DM16E101J-300	1
C12	637-824011	Capacitor, F. Mica, 39pf, 300V, 5%	Arco DM16E390J-300	1
CR1, 2, 4, 5, 7, 8, 9, 10	755-402107	Diode, Special	Beckman	8
CR3, 6	755-420893	Diode, Special	Beckman	2
CR11	755-815561	Diode, Silicon, 75PIV, 10ma, 1V min. fwd.	Continental CD6111	1
CR12	755-431324	Diode, Special	Beckman	1
Q1, 2, 4	755-817811	Transistor, Germanium, PNP, 150mW	Motorola 2N961	3
Q3	755-800398	Transistor, Germanium, PNP 150mW max.	Sylvania 2N404	1
R1, 5, 10, 12, 15, 17, 19	601-823107	Resistor, F. Comp., 15K, 1/4W, 10%	Allen Bradley CB1531	7
R2, 6, 8, 11, 16, 18, 20	601-815239	Resistor, F. Comp., 4.7K, 1/4W, 10%	Allen Bradley CB4721	7
R3, 28	601-823104	Resistor, F. Comp., 390Ω, 1/4W, 10%	Allen Bradley CB3911	2
R4, 23	601-822296	Resistor, F. Comp., 3.3K, 1/4W, 5%	Allen Bradley CB3321	2
R7	601-822299	Resistor, F. Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	1
R9, 13	601-823937	Resistor, F. Comp., 680Ω, 1/4W, 10%	Allen Bradley CB6811	2
R14	601-823942	Resistor, F. Comp., 3.3K, 1/4W, 10%	Allen Bradley CB3321	1
R21	601-822328	Resistor, F. Comp., 2.2K, 1/4W, 5%	Allen Bradley CB2225	1
R22	601-822531	Resistor, F. Comp., 33K, 1/4W, 5%	Allen Bradley CB3331	1
R24	601-823112	Resistor, F. Comp., 1.5K, 1/4W, 10%	Allen Bradley CB1521	1
R25	601-823941	Resistor, F. Comp., 2.7K, 1/4W, 10%	Allen Bradley CB2721	1
R27	601-823925	Resistor, F. Comp., 47Ω, 1/4W, 10%	Allen Bradley CB4701	1
R29	601-822370	Resistor, F. Comp., 510Ω, 1/4W, 5%	Allen Bradley CB4115	1
R30	601-079172	Resistor, F. Comp., 820Ω, 1/2W, 5%	Allen Bradley EB8215	1
R31	601-822301	Resistor, F. Comp., 15K, 1/4W, 5%	Allen Bradley CB1535	1
	864-412958	Pad, Transistor	Beckman	3



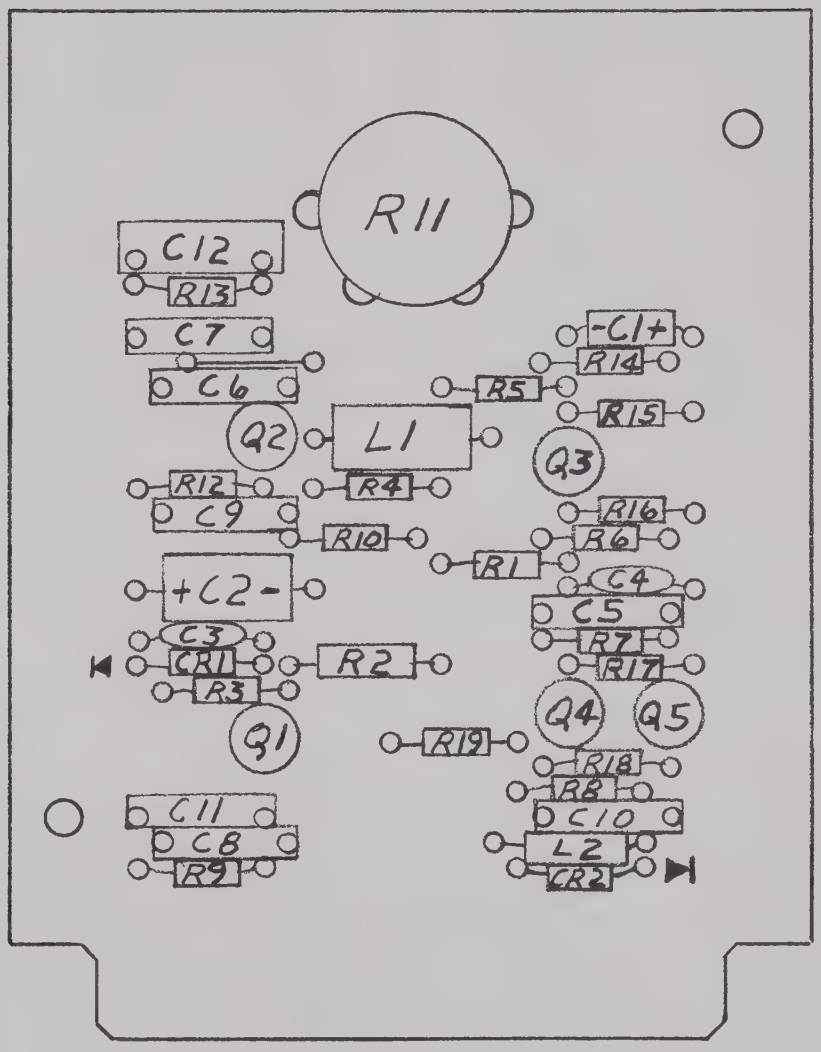
NOTE:

0) RESISTORS:
- WATTAGE —— ¼W, UNLESS NOTED.
- TOLERANCE —— 10%, " " ,

2) CAPACITORS:
- CAPACITY —— IN pf, " " ,
- VOLTAGE —— 300v, " " ,
- TOLERANCE —— 5%, " " .

3) .01μf DISC ARE -20+80%, 500v.

4) DIODES:
- * PER BECKMAN SPEC. A755-431324.
- ** " " " A755-420893



1 MC OSCILLATOR AND SHAPER
COMPONENT LAYOUT (A43)

1 MC OSCILLATOR BOARD (A43)*

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty. / Ass'y
A43	887-411676	1 Mc Oscillator Board	Beckman	1
C1	631-814053	Capacitor, F. Elect., 1μf, 35V, 20%	Sprague 150D105X0035A2	1
C2	631-802980	Capacitor, F. Elect., 22μf, 25V, 20%	Sprague 109D226X0025C2	1
C3, 4	633-804717	Capacitor, F. Cerm., 0.01μf, 500V	Sprague 29C9B5	2
C5	637-824018	Capacitor, F. Mica, 150pf, 300V, 5%	Arco DM16E151J-300	1
C6	637-824302	Capacitor, F. Mica, 300pf, 300V, 5%	Arco DM16E301J-300	1
C7	637-824028	Capacitor, F. Mica, 1000pf, 300V, 5%	Arco DM16E102J-300	1
C8, 11	637-824301	Capacitor, F. Mica, 2000pf, 300V, 5%	Arco DM20F202-300	2
C9, 10	637-824025	Capacitor, F. Mica, 560pf, 300V, 5%	Arco DM16E561J-300	2
C12	637-824303	Capacitor, F. Mica, 3900pf, 300V, 5%	Arco DM20F392-300	1
CR1	755-811280	Diode, Reference, Sil., 5V min, 5.5V max.	Cont. Devic. CD3319	1
CR2	755-402107	Diode, Special	Beckman	1
L1	795-807904	Inductor, Fixed, R. F., 0.100 mH	National RA-100-P	1
L2	795-827337	Inductor, Fixed, R. F., 0.0068 mH	National NB6.8I	1
Q1, 2	755-817216	Transistor, Germanium, PNP, 75mw max.	Philco 2N502A	2
Q3, 4	755-817811	Transistor, Germanium, PNP, 150mw	Motorola 2N961	2
Q5	755-823113	Transistor, Silicon, NPN, 800mw max.	Motorola 2N2219	1
R1	601-822327	Resistor, F. Comp., 220Ω, 1/4W, 5%	Allen Bradley CB2215	1
R2	601-015446	Resistor, F. Comp., 470Ω, 1/2W, 5%	Allen Bradley EB4715	1
R3, 9	601-822460	Resistor, F. Comp., 3.9K, 1/4W, 5%	Allen Bradley CB3925	2
R4	601-822299	Resistor, F. Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	1
R5	601-801803	Resistor, F. Comp., 12K, 1/4W, 5%	Allen Bradley CB1235	1
R6, 8	601-822306	Resistor, F. Comp., 820Ω, 1/4W, 5%	Allen Bradley CB8215	2
R7, 12	601-822295	Resistor, F. Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	2

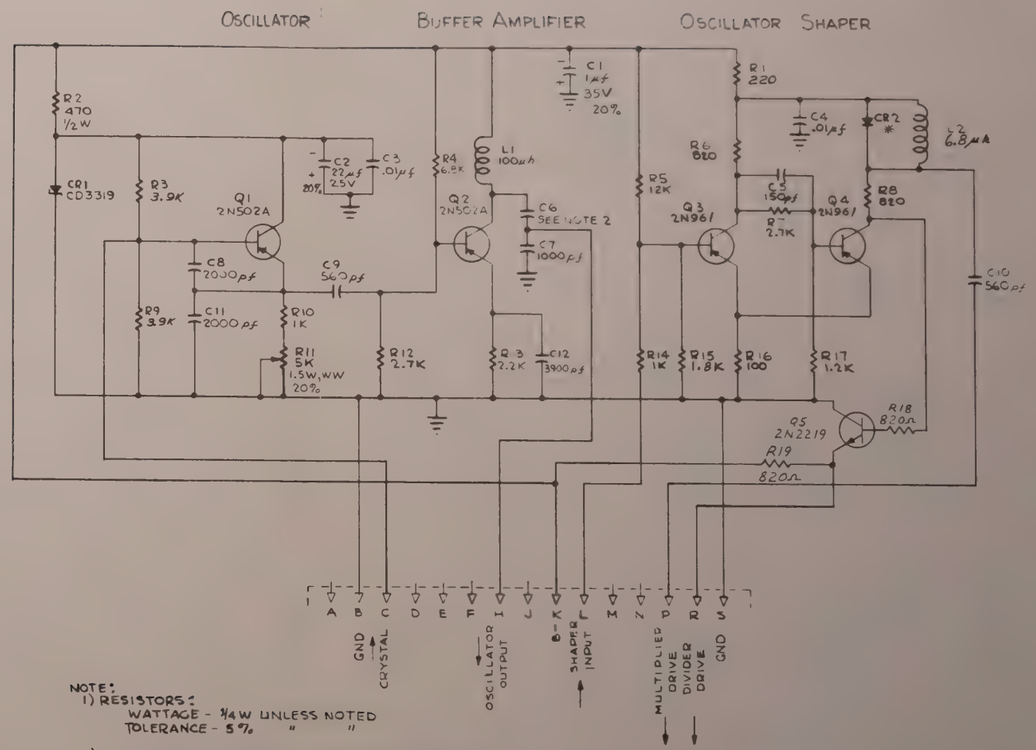
*See Outline Drawing (D415600) for associated parts.

. . . continued

1 MC OSCILLATOR BOARD (A43) - continued

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
R10, 14	601-822308	Resistor, F. Comp., 1K, 1/4W, 5%	Allen Bradley CB1025	2
R11	611-812859	Resistor, V. WW, 5K, 1-1/2W, 20%	C. T. S. Series 111	1
R13	601-822328	Resistor, F. Comp., 2.2K, 1/4W, 5%	Allen Bradley CB2225	1
R15	601-822544	Resistor, F. Comp., 1.8K, 1/4W, 5%	Allen Bradley CB1825	1
R16	601-817735	Resistor, F. Comp., 100Ω, 1/4W, 5%	Allen Bradley CB1015	1
R17	601-822326	Resistor, F. Comp., 1.2K, 1/4W, 5%	Allen Bradley CB1225	1
R18, 19	601-822306	Resistor, F. Comp., 820Ω, 1/4W, 5%	Allen Bradley CB8215	2
	864-412958	Pad, Convertor Transistor	Beckman	5

1 MC OSCILLATOR AND SHAPER (A43) SCHEMATIC DIAGRAM



NOTE:
1) RESISTORS:
WATTAGE - ¼W UNLESS NOTED
TOLERANCE - 5% " "

2) C6 NOMINALLY 300pf. IF OSCILLATOR OUTPUT IS LESS THAN 3V PP, CHANGE TO 330pf

3) CAPACITORS:
TOLERANCE — 5% UNLESS NOTED
VOLTAGE — 300V

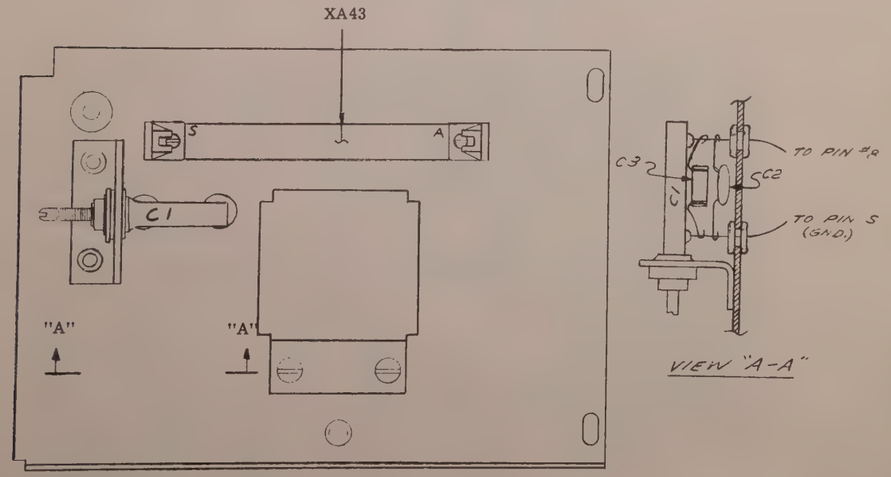
4) .01µf DISC ARE -20+80%, 500V

* 5) CR2 IS BDB #755-402107

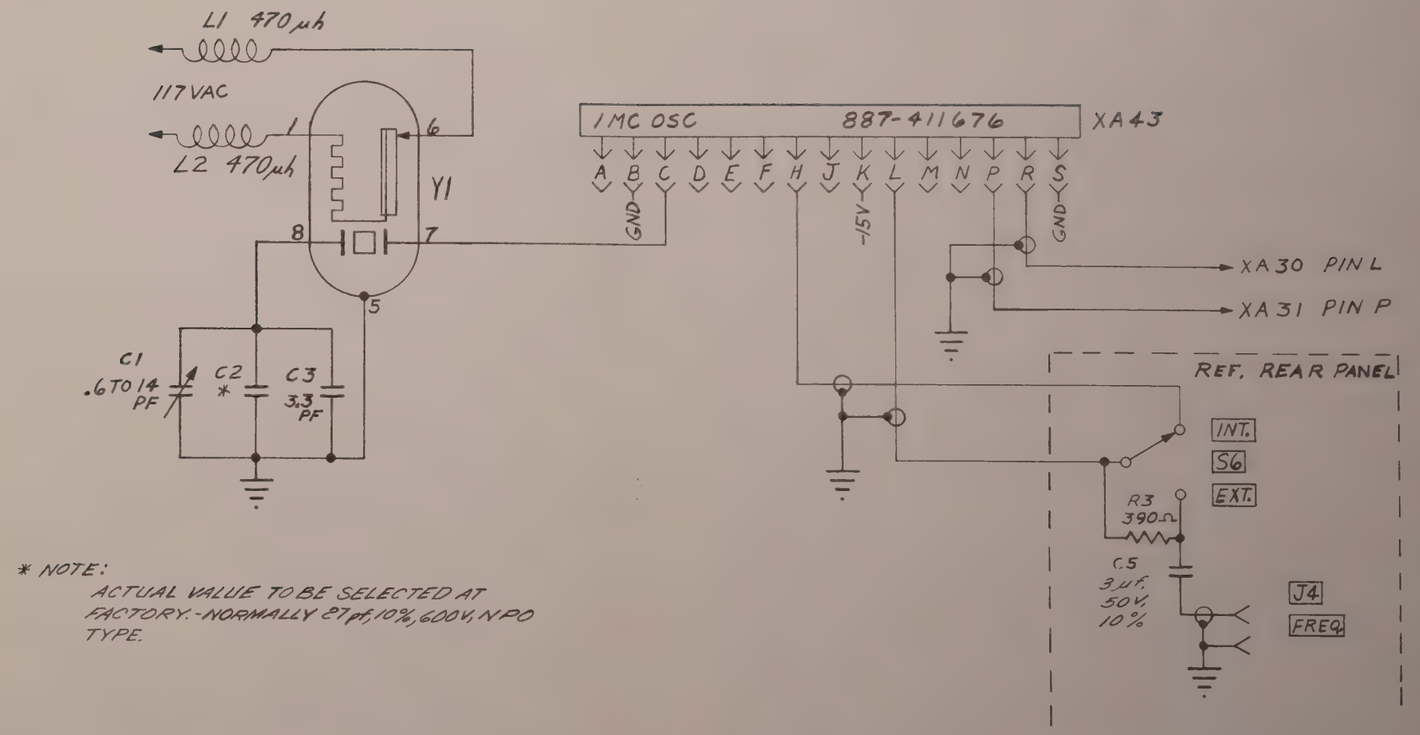
Model 6144
C411998 - Rev. C
March 1967

1 MC OSCILLATOR ASSEMBLY (A38)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
C1	655-415515	Capacitor, V. Glass, 0.6-14pf, 1000V, -40 to +50 PPM/°C	J. F. D. Elect., VC11GRA (Mod)	1
C2	xxx-xxxxxx	Factory selected value (normally 27pf, 10%, 600V)	Beckman	1
C3	633-827603	Capacitor, F. Cerm., 3.3pf, T. C. -750 PPM/°C	Centralab TCN-3R3	1
C5	639-835127	Capacitor, F. Paper, 3μf, 50V, 10%	Elpac VX5A305K	1
J4	670-806738	Connector, Coaxial, Receptacle, BNC Type	Amphenol UG-1094/U	1
L1, 2	795-807919	Inductor, F. RF, 0.470μH, 9Ω, 285 MA	Delevan 3500-24	2
R3	601-822371	Resistor, F. Comp., 390Ω, 1/4W, 5%	Allen Bradley CB3915	1
S6	716-827410	Switch, Slide, DPDT	Continental Type 126 (C-W)	1
XA43	680-823481	P. C. Connector, 15 Contacts	Cinch 250-15-70-170	1
XY1	860-802333	Socket, Tube, 8-Pin Saddle Mounting	Cinch 16203 (P/O 40-415714)	1
Y1	881-430340	Crystal and Oven Assembly	Beckman	1
	430-415711	Chassis Oscillator	Beckman	1
	864-415712	Insulator, Oven Clamp Bracket	Beckman	1



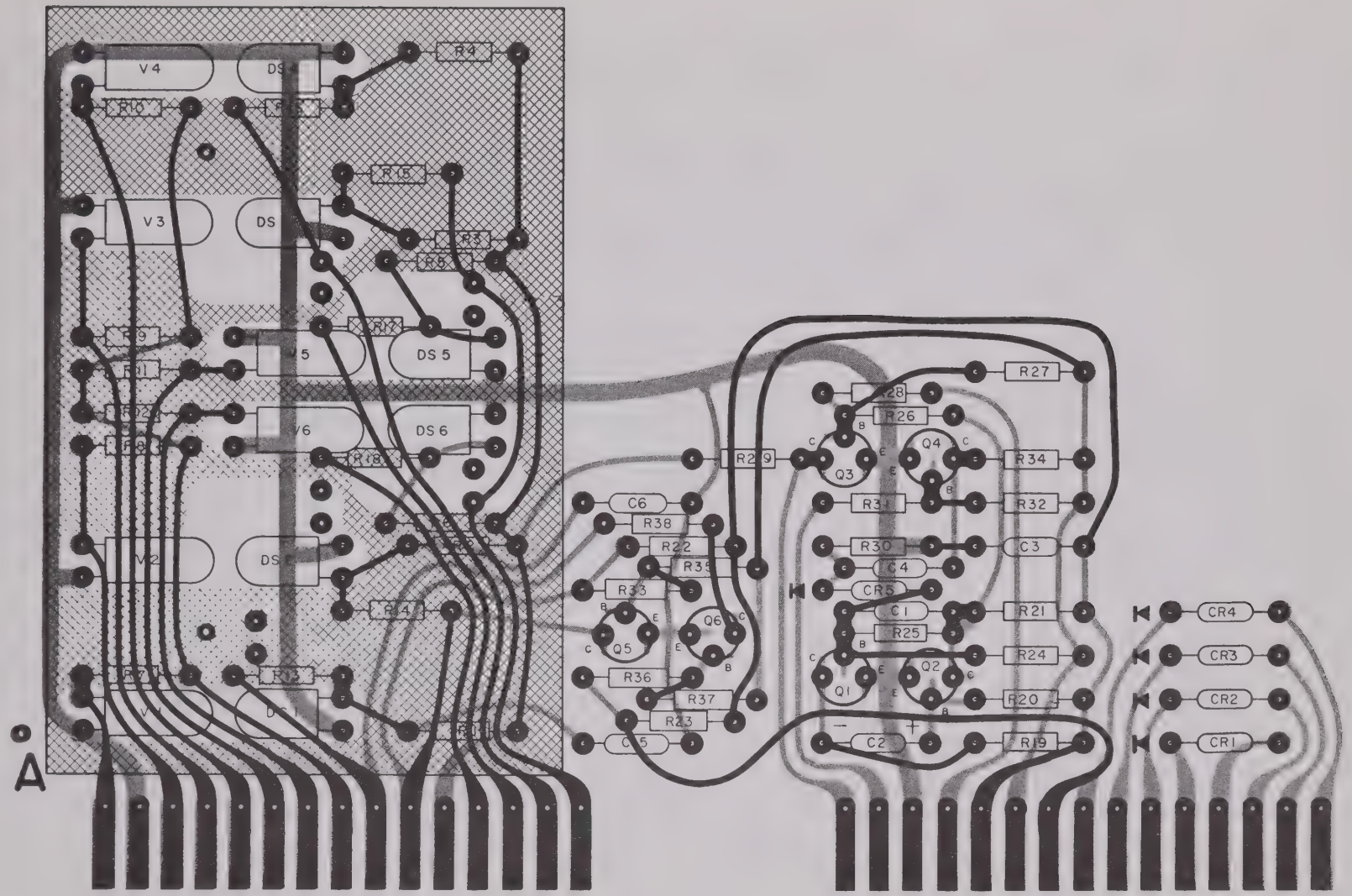
(C415715-C)



* NOTE:
ACTUAL VALUE TO BE SELECTED AT FACTORY.-NORMALLY 27 pf, 10%, 600V, NPO TYPE.

Model 6144
B418235-B Rev. E
March 1967

Beckman

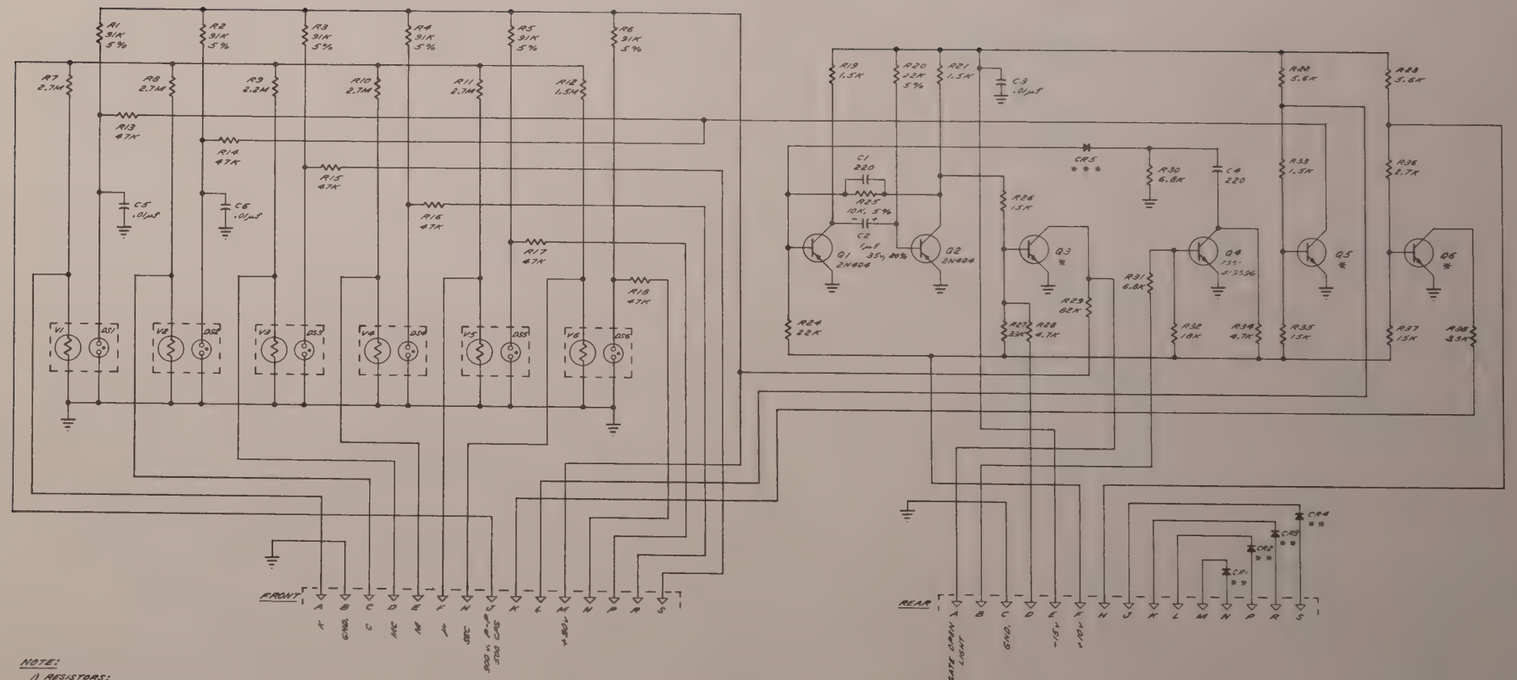


LEGEND COMPONENT LAYOUT (A32)

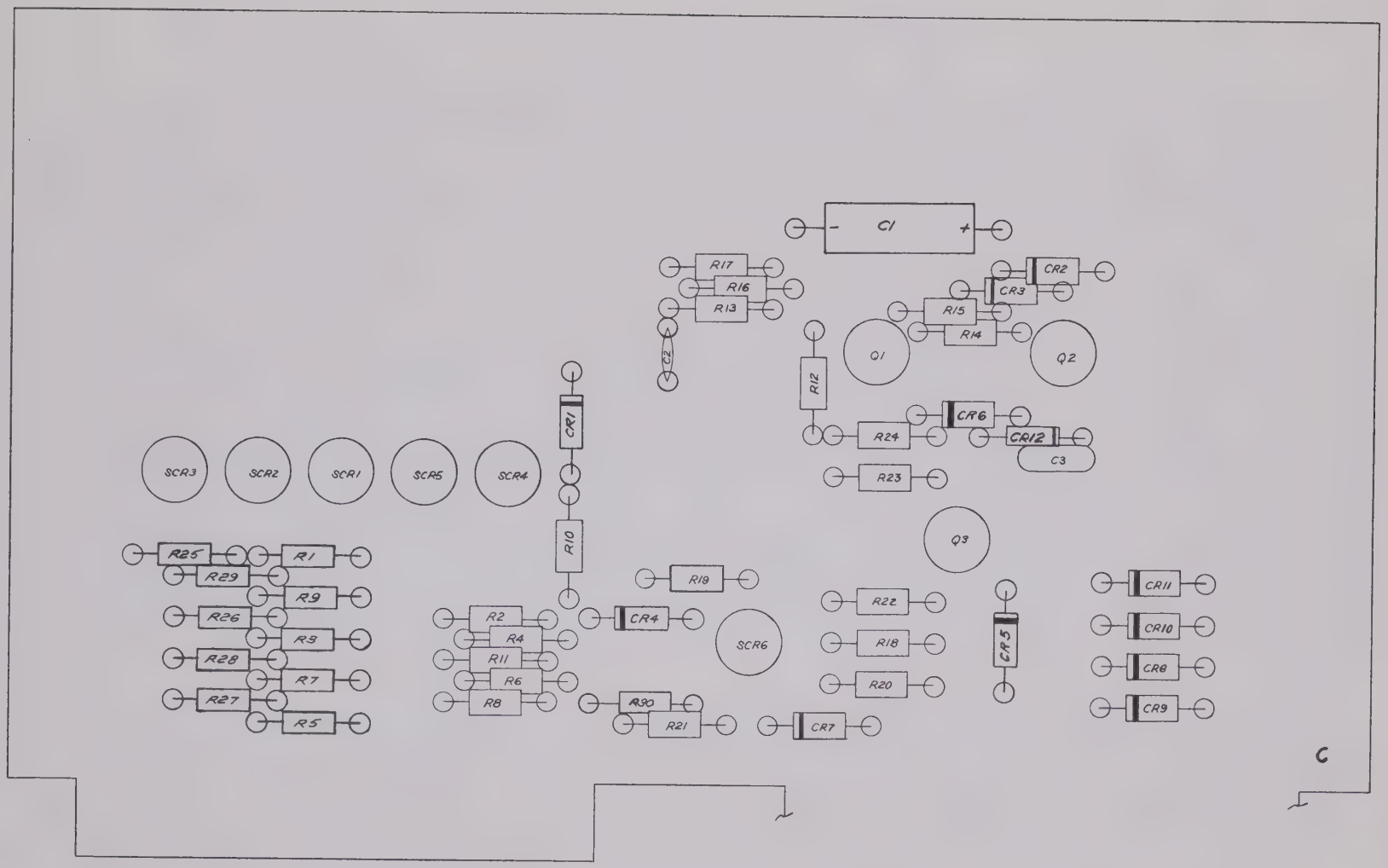
Model 6144
64C-6100-009-Rev. C
March 1967

LEGEND BOARD (A32)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A32	887-418075	Legend Board	Beckman	1
C1, 4	637-824020	Capacitor, F. Mica, 220pf, 300V, 5%	Arco DM16E221J-300	2
C2	631-814053	Capacitor, F. Elect., 1μf, 35V, 20%	Sprague 150D105X0035A2	1
C3, 5, 6	633-804717	Capacitor, F. Cerm., 0.01μf, 500V	Sprague 29C9B5	3
CR1, 2, 3, 4	755-815561	Diode, Silicon, 75PIV, 10ma, 1V min. fwd.	Continental CD6111	4
CR5	755-404593	Diode, Special	Beckman	1
DS1, 2, 3, 4, 5, 6	825-414955	Lamp, Neon, Special	Beckman	6
Q1, 2	755-800398	Transistor, Germ., PNP, 150mw max.	Sylvania 2N404	2
Q3, 5, 6	755-410066	Transistor, Special	Beckman	3
Q4	755-419596	Transistor, Special	Beckman	1
R1, 2, 3, 4, 5, 6	601-822337	Resistor, F. Comp., 91K, 1/4W, 5%	Allen Bradley CB9135	6
R7, 8, 10, 11	601-824112	Resistor, F. Comp., 2.7M, 1/4W, 10%	Allen Bradley CB2751	4
R9	601-824831	Resistor, F. Comp., 2.2M, 1/4W, 10%	Allen Bradley CB2251	1
R12	601-824832	Resistor, F. Comp., 1.5M, 1/4W, 10%	Allen Bradley CB1551	1
R13, 14, 15, 16, 17, 18	601-823951	Resistor, F. Comp., 47K, 1/4W, 10%	Allen Bradley CB4731	6
R19, 21, 33	601-823112	Resistor, F. Comp., 1.5K, 1/4W, 10%	Allen Bradley CB1521	3
R20	601-822334	Resistor, F. Comp., 22K, 1/4W, 5%	Allen Bradley CB2235	1
R22, 23	601-823944	Resistor, F. Comp., 5.6K, 1/4W, 10%	Allen Bradley CB5621	2
R24	601-823110	Resistor, F. Comp., 22K, 1/4W, 10%	Allen Bradley CB2231	1
R25	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	1
R26, 35, 37	601-823107	Resistor, F. Comp., 15K, 1/4W, 10%	Allen Bradley CB1531	3
R27, 38	601-823109	Resistor, F. Comp., 33K, 1/4W, 10%	Allen Bradley CB3331	2
R28, 34	601-815239	Resistor, F. Comp., 4.7K, 1/4W, 10%	Allen Bradley CB4721	2
R29	601-823954	Resistor, F. Comp., 82K, 1/4W, 10%	Allen Bradley CB8231	1
R30, 31	601-823945	Resistor, F. Comp., 6.8K, 1/4W, 10%	Allen Bradley CB6821	2
R32	601-823948	Resistor, F. Comp., 18K, 1/4W, 10%	Allen Bradley CB1831	1
R36	601-822295	Resistor, F. Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	1
V1, 2, 3, 4, 5, 6	753-416278	Photo-Resistor, End-View, Special	Beckman	6
	864-412958	Pad, Transistor	Beckman	6
	824-414475	Lamp, Block, Cover	Beckman	1
	824-412922	Lamp, Block, Base	Beckman	1



NOTE:
1) RESISTORS:
WATTAGE —— 1/4 W., UNLESS NOTED.
TOLERANCE —— 10%, " " ,
2) CAPACITORS:
CAPACITY —— IN MF., " " ,
VOLTAGE —— 300 V., " " ,
TOLERANCE —— 5%, " " ,
3) .01μF DISC ARE -20+80%, 500 V.
4) ALL NEON BULBS ARE TO BECKMAN SPEC. DWG. A065-618935. (DS1 THRU DS6)
5) ALL PHOTOTRANSISTORS ARE TO BECKMAN SPEC. DWG. A753-618278. (V1 THRU V6)
6) * — TRANSISTORS ARE TO BECKMAN SPEC. DWG. A755-610256.
7) ** — DIODES ARE TO BECKMAN SPEC. PART NO. 755-813361. (CR8,11)
8) *** — DIODE TO BECKMAN SPEC. DWG. NO. A759-606533.



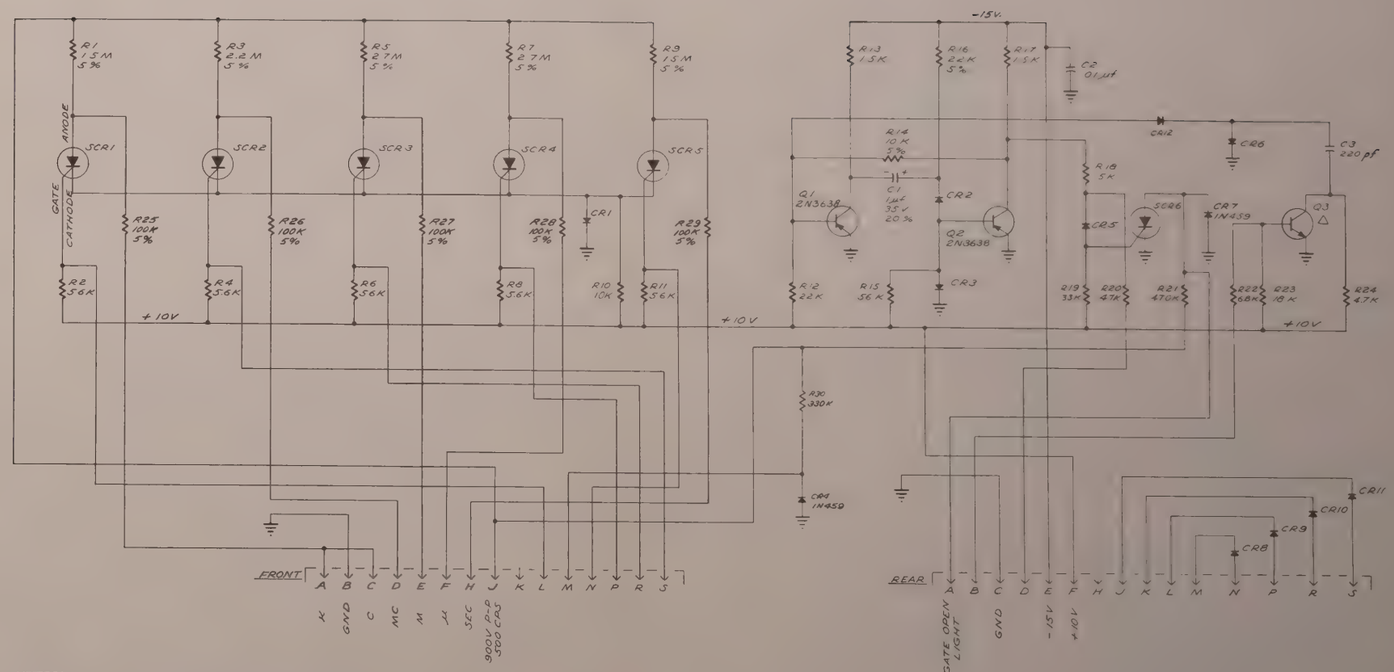
LEGEND COMPONENT LAYOUT (A32)

Model 6144
C-631226 Rev. E
March 1967

Beckman

LEGEND BOARD (A32)

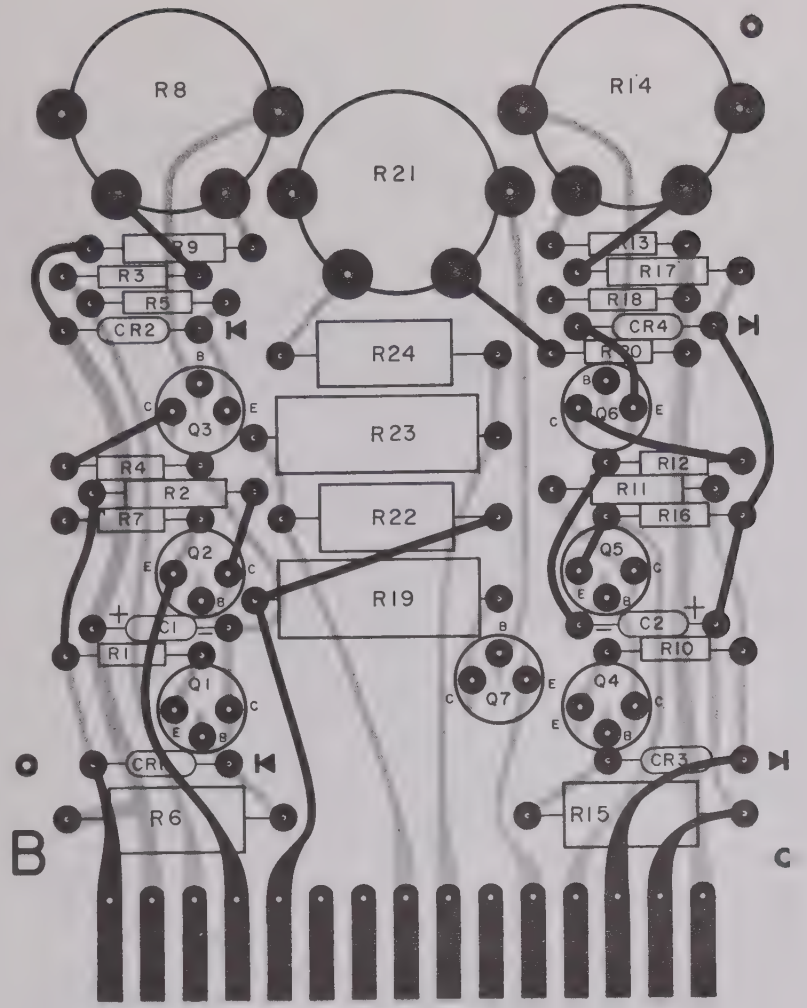
Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A32	887-431226	Legend Board	Beckman	1
C1	631-802881	Capacitor, F. Elect., 1μf, 25V	Sprague 30D105G025BA2	1
C2	633-804715	Capacitor, F. Cerm., 0.01μf, 50V	Sprague 19C214	1
C3	637-822986	Capacitor, D. Mica, 220pf, 500V, 5%	Electromotive DM15F221J0-500WV4CR	1
CR1, 2, 3, 5, 6, 8, 9, 10, 11, 12	755-431324	Diode, Special	Beckman	10
CR4, 7	755-814091	Diode, Type 1N459	Texas Instruments	2
Q1, 2	755-838105	Transistor, Type 2N3638	Fairchild	2
Q3	755-419596	Transistor, Special	Beckman	1
R1, 9	601-825378	Resistor, F. Comp., 1.5M, 1/4W, 5%	Allen Bradley CB1555	2
R2, 4, 6, 8, 11	601-823944	Resistor, F. Comp., 5.6K, 1/4W, 10%	Allen Bradley CB5621	5
R3	601-819691	Resistor, F. Comp., 2.2M, 1/4W, 5%	Allen Bradley CB2255	1
R5, 7	601-819693	Resistor, F. Comp., 2.7M, 1/4W, 5%	Allen Bradley CB2755	2
R10, 14	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	2
R12, 16	601-822334	Resistor, F. Comp., 22K, 1/4W, 5%	Allen Bradley CB2235	2
R13, 17	601-823112	Resistor, F. Comp., 1.5K, 1/4W, 10%	Allen Bradley CB1521	2
R15	601-823952	Resistor, F. Comp., 56K, 1/4W, 10%	Allen Bradley CB5631	1
R18	601-823107	Resistor, F. Comp., 15K, 1/4W, 10%	Allen Bradley CB1531	1
R19	601-823109	Resistor, F. Comp., 33K, 1/4W, 10%	Allen Bradley CB3331	1
R20	601-815239	Resistor, F. Comp., 4.7K, 1/4W, 10%	Allen Bradley CB4721	1
R21, 24	601-823961	Resistor, F. Comp., 470K, 1/4W, 10%	Allen Bradley CB4741	2
R22	601-823945	Resistor, F. Comp., 6.8K, 1/4W, 10%	Allen Bradley CB6821	1
R23	601-823948	Resistor, F. Comp., 18K, 1/4W, 10%	Allen Bradley CB1831	1
R25, 26, 27, 28, 29	601-823904	Resistor, F. Comp., 100K, 1/4W, 5%	Allen Bradley CB1045	5
R30	601-823910	Resistor, F. Comp., 330K, 1/4W, 5%	Allen Bradley CB3345	1
SCR1, 2, 3, 4, 5, 6	755-431528	Silicon Controlled Rectifier	Beckman	6
	864-412958	Transistor Pad	Beckman	7



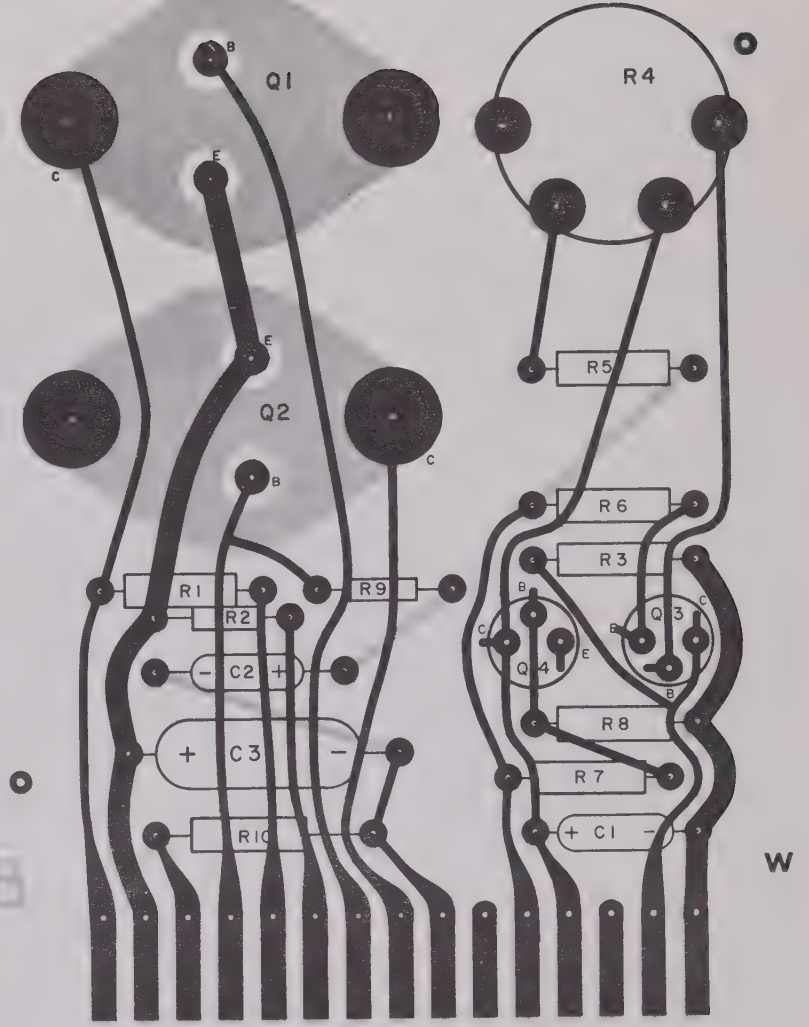
NOTES:
1. RESISTORS: 1/4 W, 10% EXCEPT AS NOTED.
2. DIODES: PER BECKMAN SPEC. A755-431324 EXCEPT AS NOTED.
3. TRANSISTORS:

△ ARE PER BECKMAN SPEC. A755-419596

4. SCR's ARE PER BECKMAN SPEC. A755-431528.



Regulator



EL Supply

POWER SUPPLY COMPONENT LAYOUTS (A34 & A35)

Model 6144
643-6100-021-Rev. L
March 1967

Model 6144
643-6100-022-Rev. L
March 1967

REGULATOR BOARD (A34)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A34	887-412442	Regulator Board	Beckman	1
C1, 2	631-814053	Capacitor, F.Elect., 1μf, 33V, 20%	Sprague 150D105X0035A2	2
CR1, 3	755-404593	Diode, Silicon, Special	Beckman	2
CR2, 4	755-814019	Diode, Zener, 400mw	Motorola 1N754A	2
Q1, 4	755-811274	Transistor, Type 2N445A	Gen. Trans. 2N445A	2
Q2, 3, 5, 6	755-838105	Transistor, Type 2N3638	Fairchild, Type 2N3638	4
Q7	755-415078	Transistor, Special	Beckman	1
R1, 10	601-823934	Resistor, F.Comp., 270Ω, 1/4W, 10%	Allen Bradley CB2711	2
R2	601-008065	Resistor, F.Comp., 100Ω, 1/2W, 10%	Allen Bradley EB1011	1
R3, 13	601-823104	Resistor, F.Comp., 390Ω, 1/4W, 10%	Allen Bradley CB3911	2
R4, 12	601-823105	Resistor, F.Comp., 470Ω, 1/4W, 10%	Allen Bradley CB4711	2
R5	601-823112	Resistor, F.Comp., 1.5K, 1/4W, 10%	Allen Bradley CB1521	1
R6, 15	601-008059	Resistor, F.Comp., 2.2K, 1W, 10%	Allen Bradley GB2221	2
R7, 16	601-815239	Resistor, F.Comp., 4.7K, 1/4W, 10%	Allen Bradley CB4721	2
R8, 14	611-812861	Resistor, V. WW, 200Ω, 1.5W, 20%	C.T.S. Series 111	2
R9, 17	601-008071	Resistor, F.Comp., 330Ω, 1/2W, 10%	Allen Bradley EB3311	2
R11	601-008068	Resistor, F.Comp., 180Ω, 1/2W, 10%	Allen Bradley EB1811	1
R18	601-812856	Resistor, F.Comp., 2.2K, 1/4W, 10%	Allen Bradley CB2221	1
R19	601-800143	Resistor, F.Comp., 3.3K, 2W, 5%	Allen Bradley EB3325	1
R20	601-822296	Resistor, F.Comp., 3.3K, 1/4W, 5%	Allen Bradley CB3321	1
R21	601-812860	Resistor, Var., WW, 2000Ω, 1.5W, 20%	Chicago Tel. Series 111	1
R22	601-016229	Resistor, F.Comp., 1.5K, 1W, 5%	Allen Bradley GB1525	1
R23	601-800132	Resistor, F.Comp., 680Ω, 2W, 5%	Allen Bradley GB6811	1
R24	601-043215	Resistor, F.Comp., 18K, 1W, 5%	Allen Bradley GB1835	1
	864-412958	Pad, Transistor	Beckman	6

EL SUPPLY BOARD (A35)

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A35	887-412795	EL Supply Board	Beckman	1
C1	631-824631	Capacitor, F.Elect., 10μf, 20V, 20%	Fansteel STA-621-1	1
C2	631-802980	Capacitor, F.Elect., 22μf, 25V, 20%	Sprague 109D226X0025C2	1
C3	631-841374	Capacitor, F.Elect., 150μf, 20V, 10%	Mallory MTP157K020	1

. . . continued

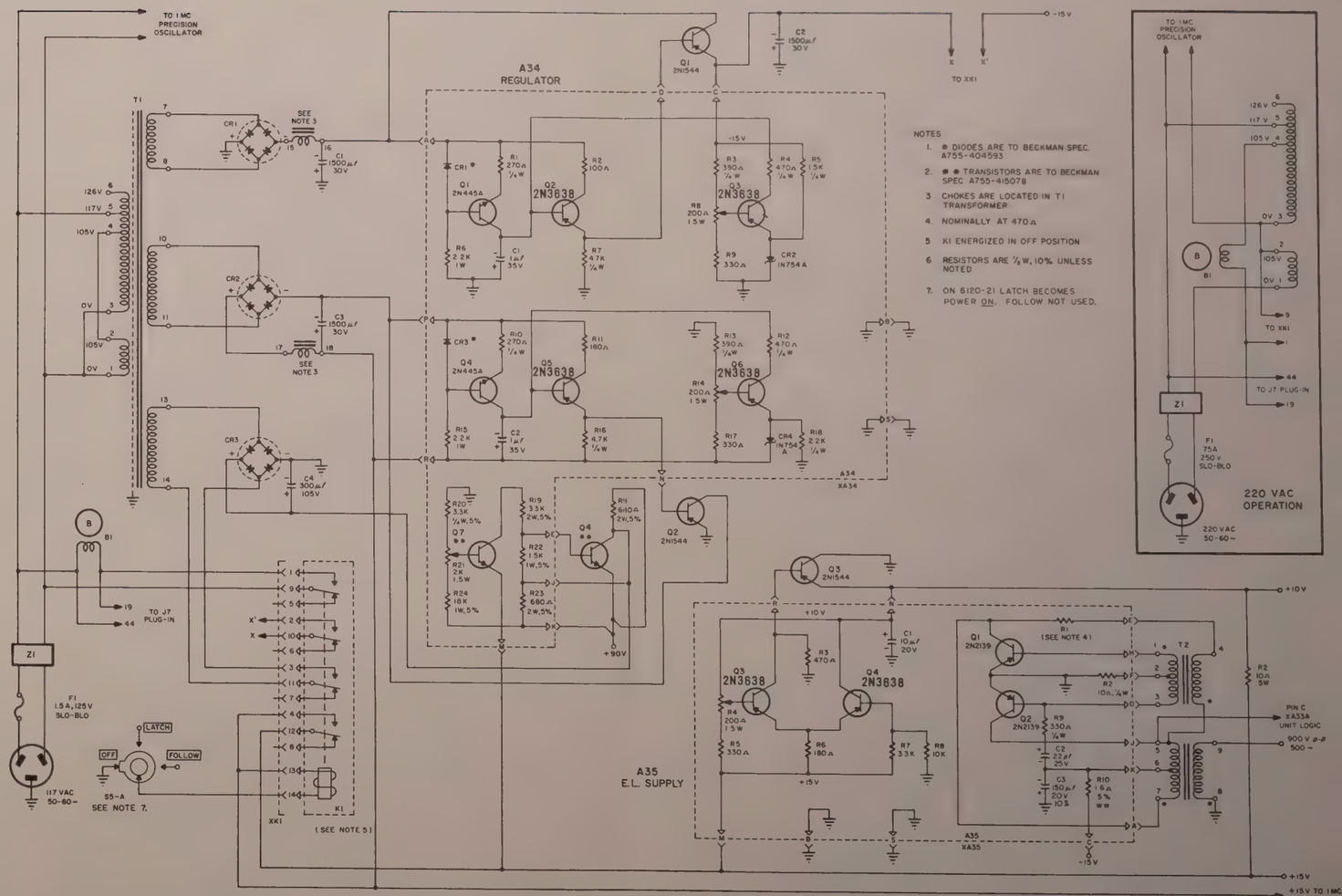
EL SUPPLY BOARD (A35) - continued

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
Q1, 2	755-824875	Transistor, Germ., PNP, 63W	Motorola 2N2139	2
Q3, 4	755-838105	Transistor, Type 2N3638	Fairchild, Type 2N3638	2
R1, 3	601-800031	Resistor, F. Comp., 470Ω, 1/2W, 10%	Allen Bradley EB4711	2
R2	601-823917	Resistor, F. Comp., 10Ω, 1/4W, 10%	Allen Bradley CB1001	1
R4	611-812861	Resistor, V. WW, 200Ω, 1.5W, 20%	C.T.S. Series 111	1
R5	601-008071	Resistor, F. Comp., 330Ω, 1/2W, 10%	Allen Bradley EB3311	1
R6	601-008068	Resistor, F. Comp., 180Ω, 1/2W, 10%	Allen Bradley EB1811	1
R7	601-010684	Resistor, F. Comp., 3.3K 1/2W, 10%	Allen Bradley EB3321	1
R8	601-007932	Resistor, F. Comp., 10K, 1/2W, 10%	Allen Bradley EB1031	1
R9	601-823935	Resistor, F. Comp., 330Ω, 1/4W, 10%	Allen Bradley CB3311	1
R10	604-817358	Resistor, F. WW, 1.5Ω, 1/2W, 5%	I.R.C. BW	1
	864-412958	Pad, Transistor	Beckman	2

MISCELLANEOUS PARTS
(Power Supply)

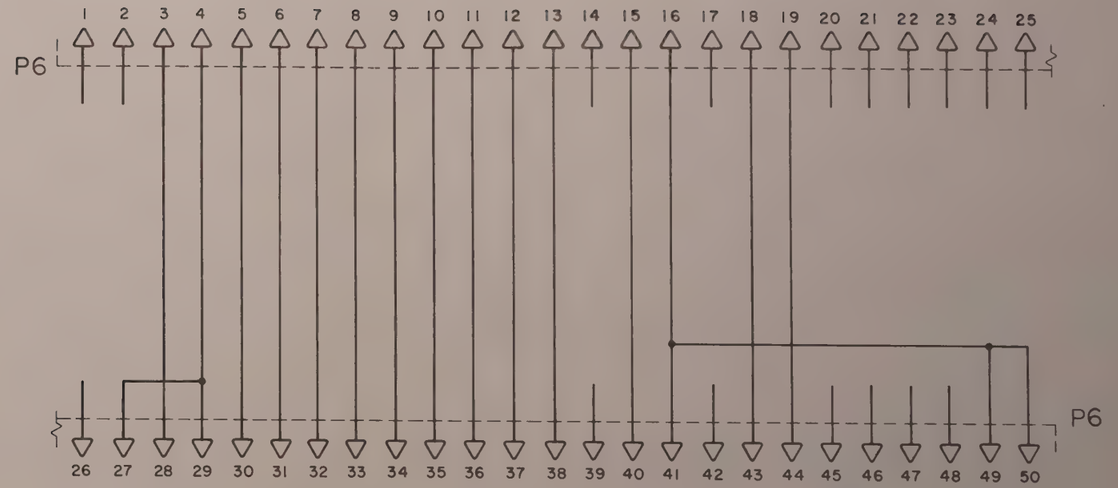
Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
C1, 2, 3	631-412828	Capacitor, F.Elect., 1500μf, 30V	Beckman	3
C4	631-410854	Capacitor, F.Elect., 300μf, 150V	Beckman	1
CR1	774-824971	Rectifier Bridge, 3 amps	Semtech SA780	1
CR2, 3	774-824972	Rectifier Bridge, 1.5 amps	Semtech SCBR2	2
F1	731-801567	Fuse, Electrical, 1.5 amp, at 125V T.D.	Littelfuse 31301.5	1
K1	718-827701	Relay, 12V, 4Form C	Potter-Brum. KHP 17D12	1
Q1, 2, 3	755-822107	Transistor, Germ., PNP, 2ma max.	Motorola 2N1544	3
Q4	755-415078	Transistor, Special	Beckman	1
R2	604-801990	Resistor, F. WW, 10Ω, 5W, 10%	Tru-Ohm FRL-5-10-10%	1
R8	601-800132	Resistor, F.Comp., 680Ω, 2W, 5%	Allen Bradley HB6815	1
T1	792-411294	Transformer, Power	Beckman	1
T2	792-411415	Transformer, EL	Beckman	1
XF1	735-007268	Fuseholder, 15 amp at 250V breakdown	Bussman HKP	1
XK1	860-824956	Socket, Relay	Potter-Brum. 27E008	1
Z1	771-416479	Filter, Interference	Beckman	1

POWER SUPPLY (A34 & A35)
SCHEMATIC DIAGRAM



Model 6144
64D-6100-023-Rev. L
March 1967

Beckman®


P6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
P6
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

MODEL 850

Decimal Counting Unit

(PREFIX 501)

Beckman
INSTRUMENTS, INC.
ELECTRONIC INSTRUMENTS DIVISION
RICHMOND, CALIFORNIA • 94804

December 1962
(REV. FEB. 1967)

WARRANTY

Instruments sold by Electronic Instruments Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in possession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company nameplate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Electronic Instruments Division of Beckman Instruments, Inc., Richmond, California, 94804.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at any of three Regional Service Centers and the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. To obtain warranty service contact your nearest Beckman Service Office, which will give you the necessary instructions for returning the instrument. Beckman Service Offices now in operation are shown on the bottom of this sheet. Instruments returned for service will be sent to the Beckman Service Office, transportation charges prepaid. The instrument will be returned to the purchaser with transportation charges prepaid.

REGIONAL SERVICE OFFICES

WESTERN
Beckman Instruments, Inc.
Electronic Instruments Division
2200 Wright Avenue
Richmond, California 94804

CENTRAL
Beckman Instruments, Inc.
Electronic Instruments Division
Post Office Box 66204
Chicago, Illinois 60666

EASTERN
Beckman Instruments, Inc.
Electronic Instruments Division
12050 Tech Road
Montgomery Industrial Park
Silver Springs, Maryland 20904

DISTRICT SERVICE OFFICES

2400 Harbor Boulevard
Fullerton, California 92634

Sahara Office Center, Suite 116
3313 Memorial Parkway, S.
Huntsville, Alabama 35801

U.S. Highway #22 at Summit Road
Mountainside, New Jersey 07091

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DIAGRAMS

Model 850 DCU Component Layout (dwg. no. A411653)
Model 850 DCU Schematic Diagram (dwg. no. C411930)

SECTION 1

INTRODUCTION

1.1 GENERAL DESCRIPTION

The Model 850 DCU is a plug-in electronic counting unit using solid state components mounted on a printed circuit board. The unit counts input pulses from zero to nine; each count is represented by output signals in binary (1-2-4-8) coded form. With an Electroluminescent Storage Unit this binary-coded output can be converted into a decimal digit display of the registered count.

At every tenth input pulse, the DCU generates an output signal suitable to drive another Model 850 DCU. Thus, any number of these units can be cascaded (the output of one connected to the input of the next) to form a counter whose total count capacity depends only on the number of DCU's.

Since each DCU generates one output pulse for every ten input pulses, these units can also be used as decade frequency dividers.

1.2 TECHNICAL CHARACTERISTICS

Count Indication

Binary-coded (1-2-4-8) electrical signals

Input Requirements

Voltage pulse, +10 to +25 volts amplitude*, 1μs minimum duration (0.5μs rise time).

Maximum Counting Rate

250,000 counts per second

Resolution of Paired Pulses

3 microseconds

---

*The values given correspond to supply voltage levels listed under "Power Requirements". For values when other supply voltages are used, see Section 2.6.

Output Characteristics

Positive signal when count goes from "9" to "0", suitable for driving another Model 850 DCU.

Reset Requirement

Voltage pulse, -10 v amplitude*, 10μs minimum duration.

Power Requirements

22 ma at -15 v. ($\pm 5\%$)
2 ma at +10 v. ($\pm 5\%$)

(NOTE: The unit can operate at other voltage levels as well; see see Section 2.6).

Construction

Printed card plug-in unit (with 15-pin printed circuit connector).

Dimensions

1/2 inch wide, 3 11/16 inches high, 3 5/32 inches deep

Weight

1 1/2 oz.

*The values given correspond to supply voltage levels listed under "Power Requirements". For values when other supply voltages are used, see Section 2.6.

SECTION 2

OPERATION

2.1 MOUNTING THE UNIT

The DCU can be mounted by plugging into a 15 pin printed-card connector. Typical connector: Ucinite 119510-MP-15C.

2.2 SUPPLYING POWER

Ordinarily, the unit operates with supply voltages of -15 volts and +10 volts, but other voltage levels can be substituted as indicated in Section 2.6. The negative voltage supply should be connected to pin K of the DCU connector, while the positive supply should be connected to pin J.

2.3 SUPPLYING INPUT SIGNALS

Connect the source of input signals to pin C of the DCU connector. The unit will register a count each time a pulse +10 to +25 volts in amplitude (with a minimum width of 1 microsecond and a 0.5 microsecond rise time) is applied to the input terminal.

Pin A (capacitor bypass) provides an alternate input. If used, this input should be driven through an external capacitor.

2.4 USING OUTPUT SIGNALS

The DCU supplies readout signals to terminals D, F, M, and P of the DCU connector. These signals are in two voltage states: -0.3 volts with respect to ground (pin S) for the binary "one", and -12 volts with respect to ground for the binary "zero". The binary states (each binary driving one readout line) represent the registered count in 1-2-4-8 binary code. Each readout line will supply a maximum steady state current of 2 ma into a load connected to B-. Table 1 indicates the state of the binaries for each registered count from 0 to 9.

Use Table 1 to convert a coded digit to a decimal digit. Note the weight of each column in which a "1" appears, then sum the weight. For example, the coded digit "1100" is equivalent to 1+2+0+0 = 3; and "0110" is equivalent to 0+2+4+0 = 6.

Table 1. State of the Binaries

DECIMAL DIGIT REGISTERED	FIRST BINARY STAGE (Weight 1)	SECOND BINARY STAGE (Weight 2)	THIRD BINARY STAGE (Weight 4)	FOURTH BINARY STAGE (Weight 8)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

The readout signals at terminals D, F, M and P drive an Electroluminescent Storage Unit for a visual indication of the registered count. In addition, the output signal produced at terminal R each time the count goes from 9 to 0 can be used to drive another Model 850 DCU or other circuitry.

2.5 RESETTING DCU TO ZERO

Reset lines H, L, and N are clamped at zero volts while the DCU counts. A negative pulse to lines H and L (line N clamped at zero volts) will reset the DCU to zero. The DCU can be set to 9 by applying a negative pulse to lines L and N (line H clamped at zero volts). A 10 microsecond, -10 volt pulse will reset the DCU. The reset pulse can be generated either electronically by transistor circuitry or mechanically through relay contacts.

2.6 SPECIAL OPERATING CONDITIONS

Although the operating characteristics described in previous sections are for power supply levels of -15 and +10 volts, the unit will function at other voltages as well. Proper combinations of B- and B+ voltages down to -8 and +4 volts respectively can successfully be used.

Those characteristics which are affected by the supply voltage levels will naturally vary with the value of the voltages used. Thus, for example, with a B- and B+ voltage of -8 and +4 volts, the amplitudes of the input, output, and reset signals will be approximately as follows (signal widths remain unchanged):

1) Input signal: +5 to +15 volts

2) Output signal: Potentials of 0 and -6 volts with respect to ground.

3) Reset signal: -10 volts

SECTION 3

CIRCUITS

3.1 THE BINARIES

The decimal counting unit consists of four binaries, each comprising a pair of p-n-p transistors connected in a scale-of-ten circuit. The transistor binaries are similar to vacuum tube binaries in that they have two stable states, and are alternately triggered from one state to the other by successive input pulses.

The major difference between the two types of binary is the operating characteristics of the transistors. In a transistor, the input impedance is low (in the order of a thousand ohms) when the base potential is negative. This low impedance allows a base current to flow and the transistor can conduct. On the other hand, a positive base potential results in a high input impedance (several hundred thousand ohms). Consequently, no base current flows and the transistor is cut off.

Assume, for example, that the first binary on the schematic diagram is initially in the "zero" state. In this state, Q2 is conducting while Q1 is cut off. A positive input voltage pulse applied through diode CR3 to the base of Q2 drives this transistor to cutoff. As a result, the base current that normally flows is diverted and Q2, therefore, stops conducting.

The same input pulse which is applied to CR3 cannot change the state of Q1 since this transistor is already cut off.

As the load current in Q2 decreases, the potential on its collector approaches B-. This change in voltage level, coupled through resistor R2 and capacitor C1 to the base of transistor Q1, drives Q1 into the active region. As a result, Q1 begins to conduct, and the amplified current flowing through R4 causes the potential on the collector to fall almost to zero. Under these conditions, the divider network consisting of R9 and R7 supplies a large enough positive potential to the base of Q2 to keep it cut off.

The binary, now in the "one" state, remains in this stable state until the next positive input pulse arrives. When this happens, Q1 is cut off, Q2 conducts, and the binary thus resumes its original state.

The collectors Q1, Q3, Q5, and Q7 are tied to terminals D, F, M, and P, respectively, of the DCU connector. A change in voltage level at each collector as the binary changes state is available as an output signal. In addition, one output of each binary is used as input to the following binary. Therefore, each binary in the DCU reverses state for every two reversals of the preceding binary.

3.2 THE SCALE-OF-TEN CIRCUIT

The scale-of-ten circuit used in the Model 850 DCU is actually a four-place binary counter wired so that it resets to zero on every tenth input pulse. Thus, for the first nine pulses, the binaries operate as in a conventional, 1-2-4-8 counter. At the count of eight, however, the negative potential on the collector of Q8 is fed back through R15 to the second binary. This places a bias on CR4 and CR5 so that the next positive pulse from Q2 will not trigger the second binary.

The tenth input pulse, then, flips the first binary to its "zero" state, but the corresponding positive transient at the collector of Q2 cannot trigger the second binary to the "one" state. However, this positive transient, coupled through C12 does trigger the fourth binary to its "zero" state.

At the tenth input pulse, therefore, all four binaries are in the "zero" state, the bias on CR2 and CR5 has been removed, and the circuit is ready for the next counting cycle.

The positive output signal from Q8, produced when the counter goes from nine to zero, can be used to drive another Model DCU. Thus, the DCU will supply one input pulse to the next DCU for every ten counts registered.

The number of counts registered by the DCU is represented in binary-coded form by the potentials on the binary readout lines. Only one output signal is available from each binary.

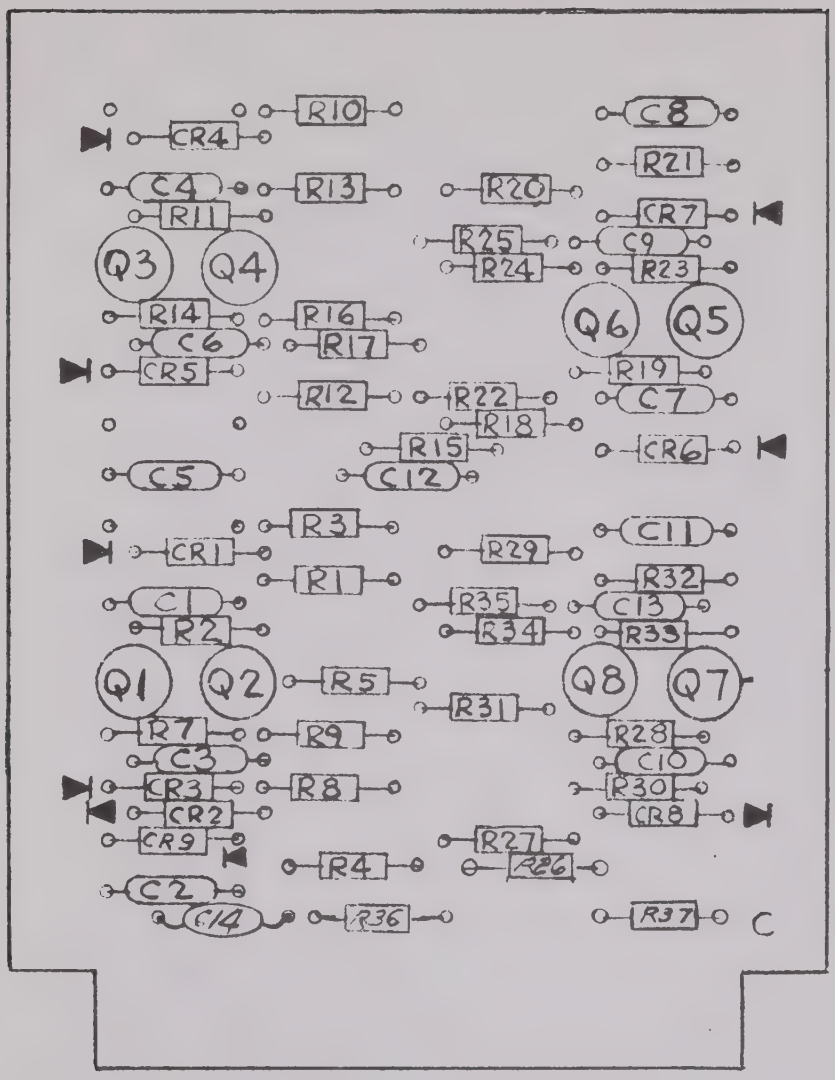
Reset lines H and L connect through a corresponding resistor to the base of the right-hand transistors (Q2, Q4, Q6, and Q8) of each binary. Reset line N connects to the base of the left-hand transistors (Q1 and Q7) of each binary. A negative voltage pulse applied to reset lines H and L (line N clamped at zero) will turn on all transistors on the right-hand side of each binary, setting the DCU to zero. A negative voltage pulse applied to reset lines L and N (line H clamped at zero) sets the DCU to nine.

SECTION 4

PARTS LIST

Detail No.	Beckman Part No.	Description	Typical Manufacturer & No.	Qty. Ass
C1	637-824020	Capacitor, F. Mica, 220pf, 300V, 5%	Electromotive DM-16E221J0-300WV4CR	8
C2	637-824018	Capacitor, F. Mica, 150pf, 300V, 5%	Electromotive DM-16E151J0-300WV4CR	1
C3 & C4		Same as C1		
C5	637-824014	Capacitor, 68pf, 300V, 5%	Electromotive DM-16E680J0-300WV4CR	2
C6 & C7		Same as C1		
C8		Same as C5		
C9 & C10		Same as C1		
C11	637-824018	Capacitor, F. Mica, 150pf, 300V, 5%	Electromotive DM-16E151J0-300WV4CR	1
C12		Same as C5		
C13		Same as C1		
C14	633-804717	Capacitor, F. Mica, 0.01μf, 500V	Sprague 29C9B5	1
CR1	755-431324	Diode, Special	Beckman	8
CR2 & CR3		Same as CR1		
CR4	755-409096	Diode, Germ., 80PIV, 4ma	Hughes 1N198	1
CR5 thru CR9		Same as CR1		
Q1	755-838105	Transistor, Germ., PNP	Fairchild 2N3638	8
Q2 thru Q8		Same as Q1		
R1	601-823108	Resistor, F. Comp., 10k, 1/4W, 10%	Allen Bradley CB1031	6
R2	601-801803	Resistor, F. Comp., 12k, 1/4W, 5%	Allen Bradley CB1235	8
R3	601-823109	Resistor, F., Comp., 33k, 1/4W, 10%	Allen Bradley CB3331	8
R4	601-823942	Resistor, F., Comp., 3.3k, 1/4W, 10%	Allen Bradley CB3321	12
R5		Same as R4		

Detail No.	Beckman Part No.	Description	Typical Manufacturer & No.	Qty./ Assy.
R7		Same as R2		
R8		Same as R1		
R9 & R10		Same as R3		
R11		Same as R2		
R12 & R13		Same as R4		
R14		Same as R2		
R15		Same as R4		
R16		Same as R1		
R17 & R18		Same as R3		
R19		Same as R2		
R20 thru R22		Same as R4		
R23		Same as R2		
R24		Same as R1		
R25		Same as R3		
R26		Same as R1		
R27		Same as R3		
R28		Same as R2		
R29 thru R32		Same as R4		
R33		Same as R2		
R34		Same as R3		
R35		Same as R1		
R36	601-823925	Resistor, F., Comp., 47Ω, 1/4W, 10%	Allen Bradley CB4701	1
R37	601-823934	Resistor, F., Comp., 270Ω, 1/4W, 10%	Allen Bradley CB2711	1
	864-412958	Transistor Pad	Beckman	8



COMPONENT LAYOUT

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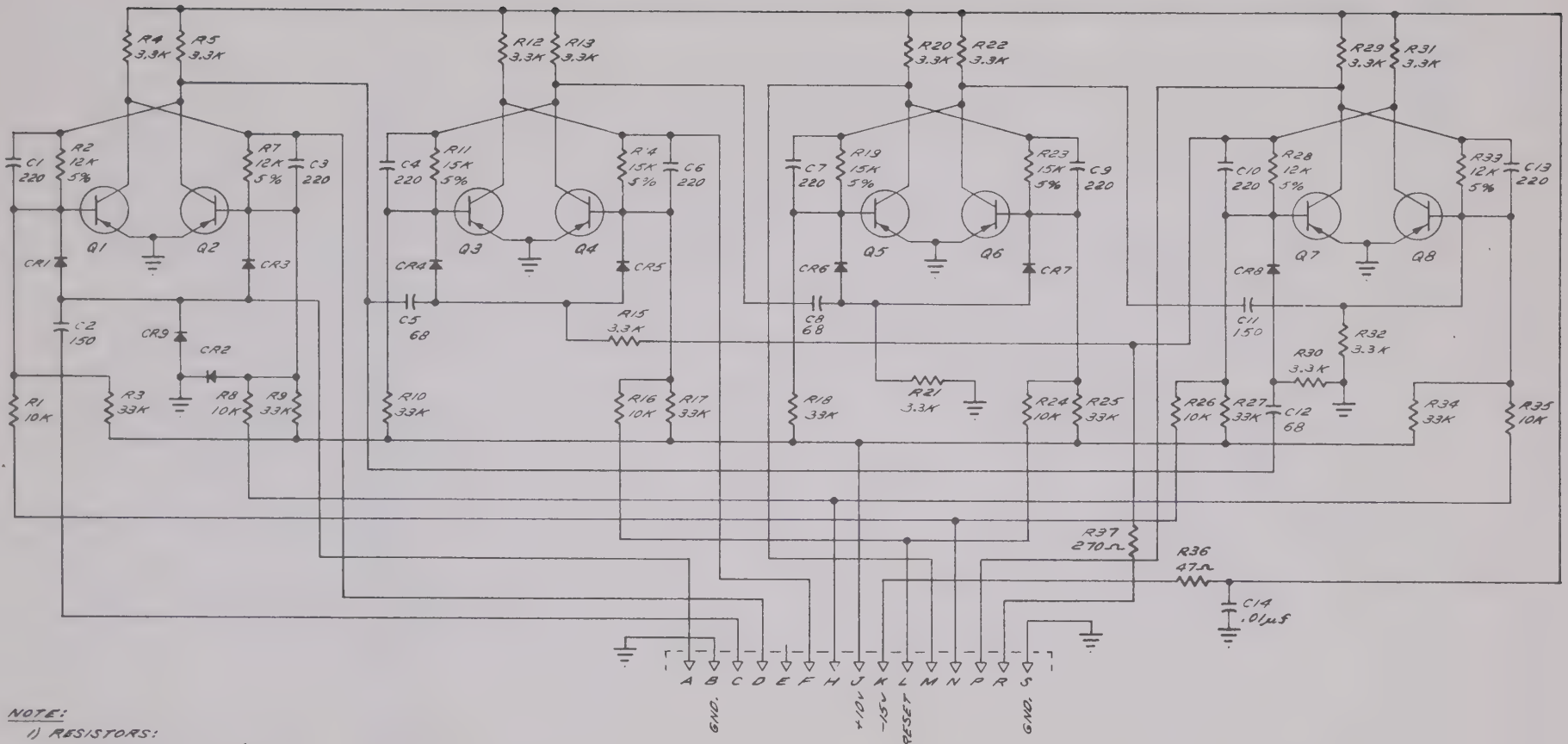
MODEL 850 DCU
SCHEMATIC DIAGRAM



NOTE:

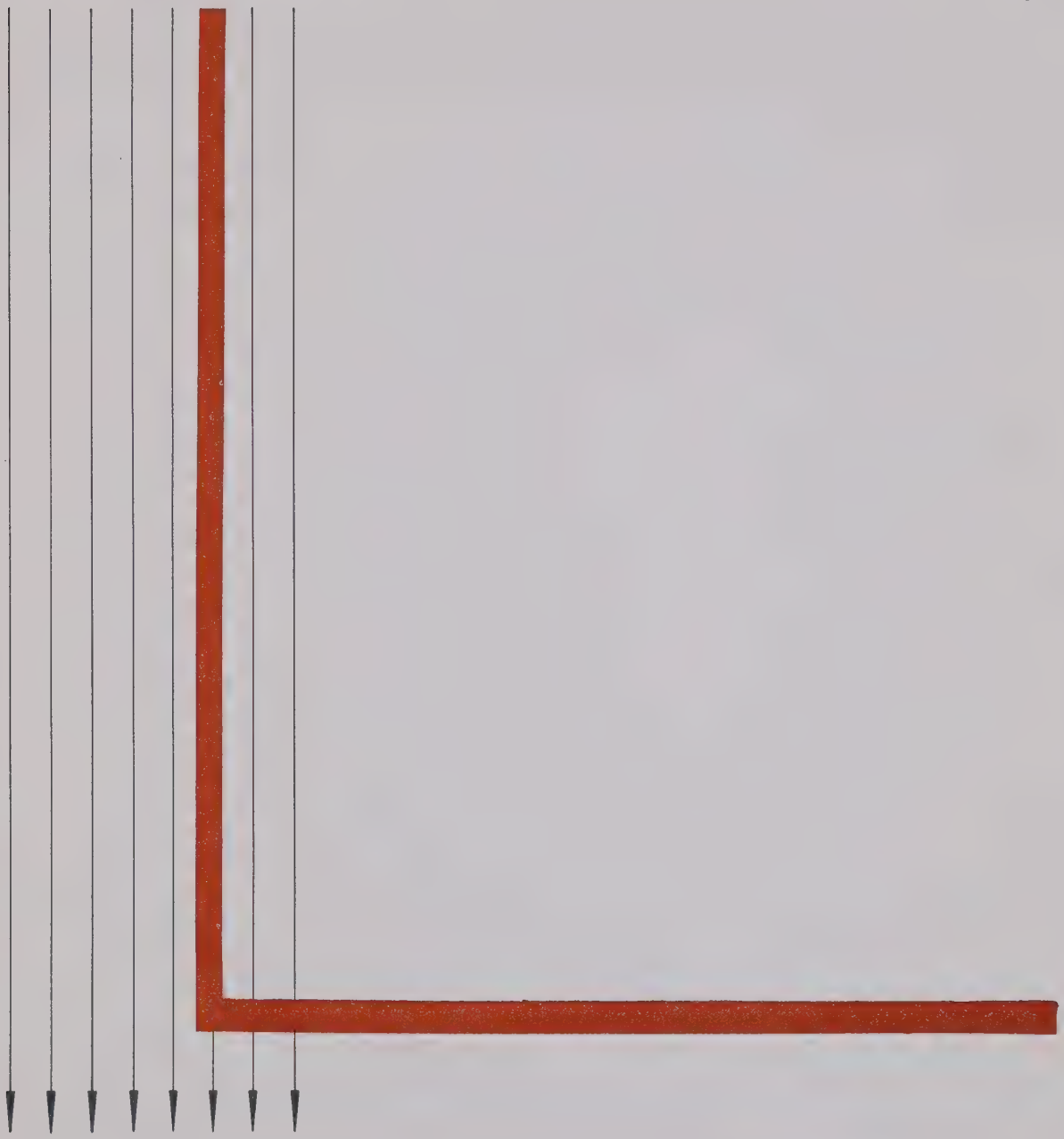
1) RESISTORS:
   - WATTAGE ——— 1/4 W., UNLESS NOTED.
   - TOLERANCE ——— 10%, " " .
2) CAPACITORS:
   - CAPACITY ——— IN Pf, " " .
   - VOLTAGE ——— 300v, " " .
   - TOLERANCE ——— 5%, " " .
3) ALL TRANSISTORS ARE 2N3638.
4) ALL DIODES ARE BECKMAN SPEC. A755-431324.

Model 850 DCU
C 411930-Rev. F
February 1967

Beckman®

INSTRUCTION MANUAL

MODEL 860A
Decimal Counting Unit



Beckman® INSTRUMENTS, INC.

BERKELEY DIVISION
2200 Wright Avenue
Richmond, California

November 1964

MODEL 860

For instruments containing Model(s) 860 DCU(s), please make the following changes to the text in this Model 860A DCU manual:

- Contents page:

  Diagrams: Model 860 DCU Component Layout (dwg. no. A411654)
  Model 860 DCU Schematic Diagram (dwg. no. D411932)

- "2.4 Using Output Signals" (Page 2-1); change the first paragraph to read as follows:

  Each of the DCU's four binaries supply readout signals in two forms: with a B- supply of -15 volts, -12 volts with respect to ground (pin S) for a binary "1", and -0.3 volts with respect to ground for a binary "0". The binary states of "1" or "0" indicate the registered count in 1-2-4-8 binary coded decimal. Each readout line will supply a maximum steady state current of 2 mA into a load connected to B-. Table 2-1 represents the binary state for each registered count from 0 to 9.

- "2.5 Resetting DCU to Zero" (Page 2-2); change to read as follows:

  Reset lines H, L, and N are clamped at zero volts while the DCU counts. Applying a negative pulse to lines H and L (line N clamped at zero volts) resets the DCU to zero. If desired, the DCU can be set to 9 by applying a negative pulse to lines L and N (line H clamped at zero volts). A 1 microsecond, -10 volts pulse is necessary to effect reset. The reset pulse can be generated either electronically by transistor circuitry or mechanically through relay contacts.

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DIAGRAMS

Model 860A DCU Schematic Diagram (D420831)

SECTION 1

INTRODUCTION

1.1 GENERAL DESCRIPTION

The Model 860A DCU is a plug-in electronic counting unit using solid state components mounted on a printed circuit board. The unit provides a count of input pulses from zero to nine, each count being represented by output signals in binary (1-2-4-8) coded decimal form.

At every tenth input pulse, the DCU generates an output signal suitable to drive a Model 850, 860, or 860A DCU. Thus, any number of these units can be cascaded (the output of one connected to the input of the next) to from a counter whose total count capacity depends only on the number of DCU's.

Since each DCU generates one output pulse for every ten input pulses, these units can also be used as decade frequency dividers.

1.2 TECHNICAL CHARACTERISTICS

Table 1-1 lists the technical characteristics of the Model 860A DCU.

Table 1-1

Count Indication	Binary-coded decimal (1-2-4-8) electrical signals.
Input Requirements	Positive pulse or voltage step, 6 volts to 8 volts amplitude (+7 recommended), 10 nanoseconds rise-time. Pulse duration 30 nanoseconds, minimum.
Counting Rate	2.5 megacycles, maximum.

continued. . .

Table 1-1 - continued

Output Characteristics	1-2-4-8 permuted binary code. Output signals are available from one side of each binary; the output may be taken from the opposite side of each binary after a slight circuit modification. (Output voltage levels are -0.2 volts and -13 volts. Carry pulse output designed to drive a following Model 860 DCU, 850 DCU, or 860A DCU.
Reset Requirements	Negative pulse or voltage level change. Reset time held at 0 volts. At reset, line is driven to -15 volts for 150 nanoseconds.
Power Requirements	45 ma at -15 volts and 4 ma at +10 volts.
Transfer Time	100 Nanoseconds between application of tenth input pulse and start of output pulse.
Transistors	Germanium, two 2N960, and six 2N968. Soldered into circuit.
Dimensions	1/2 inch wide, 3-11/16 inches high, 3-5/32 inches deep.
Weight	1-1/2 oz.
Connector Required	Ucinite 119510-MP-15C. Beckman Part No. 680-815353.

SECTION 2

OPERATION

2.1 MOUNTING THE UNIT

The DCU plugs into a 15-pin printed-card connector. Typical connector: Ucinite 119510-MP-15C.

2.2 SUPPLYING POWER

Ordinarily, the unit operates with supply voltages of -15 volts and +10 volts. The negative voltage supply connects to pin K of the DCU connector, and the positive supply to pin J. Supply voltage tolerance ±10%.

2.3 SUPPLYING INPUT SIGNALS

Connect the input signal to pin C of the DCU connector. The unit registers a count each time a pulse +6 to +8 volts in amplitude (with a minimum width of 30 nanoseconds and a 10 nanoseconds rise time) is applied to the input terminal.

Pin A (capacitor bypass) provides an alternate input. If used, this input should be driven through an external capacitor.

2.4 USING OUTPUT SIGNALS

Each of the four binaries in the DCU may be triggered to one of two stable states to produce the following output signals: binary "zero" and binary "one". Binary "zero" is -12 volts with respect to ground (pin S), and binary "one" is -0.3 volt with respect to ground. These output levels control the bias on output diodes CR13 through CR16.

The output signals at terminals D, F, M, or P may be selected by an N thumbwheel switch and used as a controlling factor in a coincidence circuit.

Use Table 2-1 to convert a coded digit to a decimal digit. Note the weight of each column in which a "1" appears, then sum the weights. For example, the coded digit "1010" is equivalent to 1+0+4+0 = 5; and "1001" is equivalent to 1+0+0+8 = 9.

Table 2-1. State of the Binaries

Decimal Digit Registered	1st Binary Stage (Weight 1)	2nd Binary Stage (Weight 2)	3rd Binary Stage (Weight 4)	4th Binary Stage (Weight 8)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

2.5 RESETTING DCU TO ZERO

Reset lines H, L, and N are clamped at zero volts while the DCU counts. Applying a negative pulse to lines H and L (line N clamped at zero volts) resets the DCU to zero. If desired, the DCU can be set to 9 by applying a negative pulse to lines L and N (line H clamped at zero volts). A 150 nanosecond, -15 volt pulse is necessary to effect reset. The reset pulse can be generated either electronically by transistor circuitry or mechanically through relay contacts.

SECTION 3

CIRCUITS

3.1 THE BINARIES

The decimal counting unit consists of four binaries, each comprising a pair of PNP transistor, connected in a scale-of-ten circuit. The binaries have two stable states and are alternately triggered from one state to the other by successive input pulses.

In a PNP transistor, the input impedance is low (in the order of a thousand ohms) when the base potential is negative. This low input impedance permits a base current to flow and the transistor conducts. On the other hand, a positive base potential results in a high input impedance (several hundred thousand ohms). Consequently, no base current flows and the transistor is cut off.

Assume, for example, that the first binary on the schematic diagram is initially in the "zero" state. In this state, Q2 is conducting while Q1 is cut off. A positive input pulse applied through diode CR4 to the base of Q2 drives this transistor to cutoff.

The pulse applied to CR1 and CR4 has no effect on the state of Q1 since this transistor is already cut off.

As the load current in Q2 decreases, the potential on its collector approaches B-. This change in voltage level, coupled through resistor R10 and capacitor C2 to the base of transistor Q1, drives Q1 into the active region. As a result, Q1 begins to conduct, and the amplified current flowing through R1 causes the potential on the collector to fall to almost zero. Under these conditions, the diode base clamp CR3 combined with the divider network R11 and R21 maintains a positive potential at the base of Q2 to keep it cut off.

The binary, now in the "one" state, remains in this stable state until the next positive input pulse arrives. At that time, Q1 cuts off, Q2 conducts, and the binary resumes its original state.

The collector of each "normally off" transistor in the four binaries connects to a corresponding terminal of the DCU connector. Thus, the change in voltage level at each collector, as the binary changes state, is available as an output signal. The change in voltage level at the collector of each "normally on" transistor is used as the drive signal to the next binary. Therefore, each binary in the DCU reverses state for every two reversals of the preceding binary.

3.2 THE SCALE-OF-TEN CIRCUIT

The scale-of-ten circuit used in the Model 860A DCU is a four-place binary counter wired so that it resets to zero on every tenth input pulse. Operation is explained in detail in the following paragraphs.

3.2.1 Initial Conditions and Circuit Fundamentals

Under initial conditions, transistors Q2, Q4, Q6, and Q8 are saturated. Transistors Q1, Q3, Q5, and Q7 are cut off. These conditions define the "zero" state for each binary.

At this point, a review of transistor binary (flip-flop) circuit fundamentals may be helpful in understanding the circuit description in the following paragraphs.

Consider the first binary, Transistors Q1 and Q2. Under initial conditions, Q1 is cut off and Q2 is saturated. Transistor Q1 is held at cutoff by divider network R18, R10, and clamp CR1. A positive input pulse applied at the junction of C10 and CR1 has no effect on Q1, since it is already cut off. While Q2 is saturated, its collector is near ground potential. Now, when the positive input pulse is applied through CR4 to the base of Q2, it drives Q2 into cutoff and the collector potential rises to approximately -12 volts. This negative transient, coupled to the base of Q1 through crossover network R10 and C2, drives Q1 into saturation.

Thus, on the first input pulse, the first binary "flips" and its transistors reverse their states. But the second binary is not affected since it takes a positive output pulse from the binary to cause the second binary to flip.

But on application of the second input pulse, circuit action produces a positive output signal to flip the second binary, as follows: the positive input pulse goes through C10 to the base of Q1 to cut it off. As Q1 cuts off, its collector potential rises to approximately -12 volts. This negative transient, coupled to the base of Q2 through crossover network R11 and C3, drives Q2 into saturation. When Q2 saturates, the collector potential goes from approximately -12 volts to approximately -0.2 volts. This positive-going pulse passes through C11 and CR6 to trigger the second binary. To summarize: a positive pulse applied to the first binary will cut off the saturated transistor, and regenerative action will drive the cut off transistor into saturation. The first binary will produce a driving pulse to the second binary only when the second transistor of the first binary goes from cutoff to saturation. Thus, the first binary will produce an output pulse only on every second input pulse, even though every input pulse will reverse the state of the binary. These principles apply to all of the binaries.

3.2.2 Sequence of Operation

Table 3-1 shows the sequence of operation.

Table 3-1

Pulse No.	Action
1	First binary flips. Q2 turns off. No output signal.
2	First binary flips. Q2 saturates. Output pulse flips second binary. Q4 turns off.
3	First binary flips. Q2 turns off. No output signal.
4	First binary flips. Q2 saturates. Output pulse from Q2 flips second binary. Q4 saturates. Output pulse from Q4 flips third binary and Q6 cuts off.
5	First binary flips. Q2 turns off. No output pulse from Q2.
6	First binary flips. Q2 saturates. Output signal from Q2 flips second binary. Q4 turns off. No output from Q4.
7	First binary flips. No output signal from Q2.
8	First binary flips. Q2 saturates. Output pulse from Q2 flips second binary. Q4 saturates. Output pulse from Q4 flips third binary. Q6 saturates. Output pulse from Q6 flips fourth binary. Q8 cuts off. Negative 12 volts at collector of Q8 is applied to CR9 and CR6 closing the gate.
9	First binary flips. No output from Q2.
10	First binary flips. Q2 saturates. Output signal from Q2 is blocked from second binary by closed gate CR9 and CR6. So it goes through C14 and CR9 to flip the fourth binary. Q8 saturates. The output pulse from Q8 goes to DCU output pin R.

3.2.3 Summary

At the tenth input pulse, all four binaries are in the "zero" state and the DCU is ready for the next counting cycle. The positive output signal from transistor Q8, produced when the counter goes from nine to zero, can drive a Model 850, 860, or 860A DCU. Thus, the counter will supply one input pulse to the next DCU for every ten counts registered.

Reset lines H and L connect through corresponding diodes to the base of the normally-on transistors (Q2, Q4, Q6, and Q8) in each binary. A negative voltage pulse applied to these reset lines will cause the normally-on transistors to conduct and trigger all binaries to the zero state.

REV	DESCRIPTION	ECO NO.	DATE	BY	CHKD	APPD
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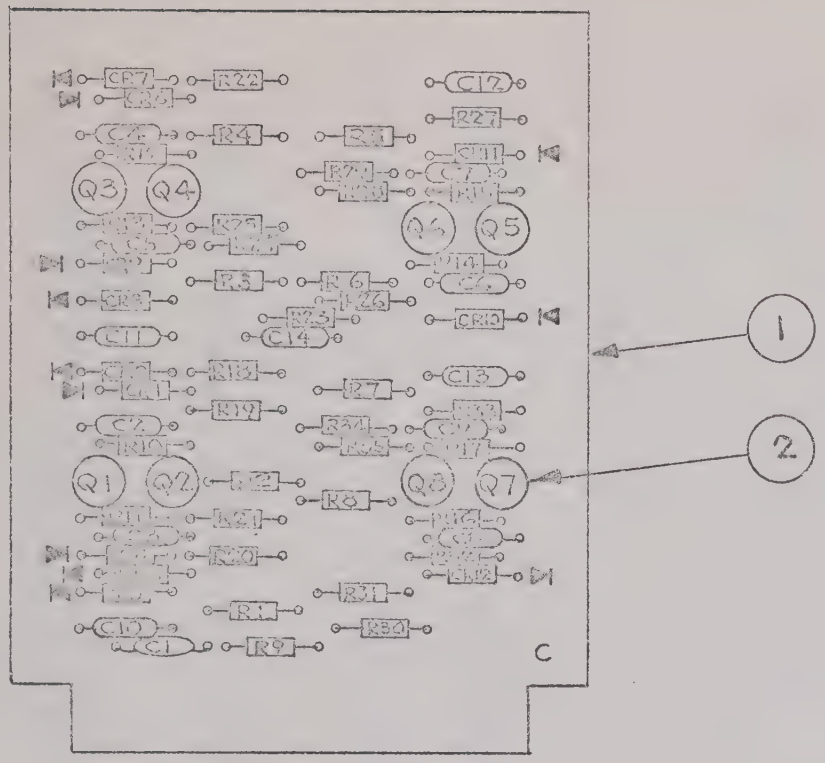

ITEM	PART NO.	DESCRIPTION	QTY.
2	A864-412958	PAD, TRANSISTOR	8
1	B693-412942	SPEC. DWG	1

NEXT ASSY.	USED ON
	6146

APPLICATION

UNLESS OTHERWISE SPECIFIED

TOLERANCES

.X	±.050	ANGULAR ±0° 30'
.XX	±.020	
.XXX	±.005	MACH. SURF. ✓

THREADS: CLASS 2A OR 2B
REMOVE BURRS & SHARP EDGES .020 MAX.
MACH. FILLET RADIUS .020 R MAX.
MACH. SURF. FLAT WITHIN .001 IN/IN
OTHER SURF. FLAT WITHIN .005 IN/IN
CONCENTRICITY MACH. SURF. TIR WITHIN ½ SUM OF DIA. TOLS., .001 MIN.

DO NOT SCALE DRAWING

	BY	DATE
DRAWN	B MILLER	8-31-62
CHKD		
ENGR	R Richmond	9-7-62
APPD	[illegible]	9/5/62
APPD		

ECO 11993

TITLE

FINAL ASSEMBLY,
860 DCU

MATERIAL

FINISH

SCALE FULL

SIZE A

Beckman®
Berkeley Division, Richmond, California

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887-411654 C

SHEET OF REV.

SECTION 4

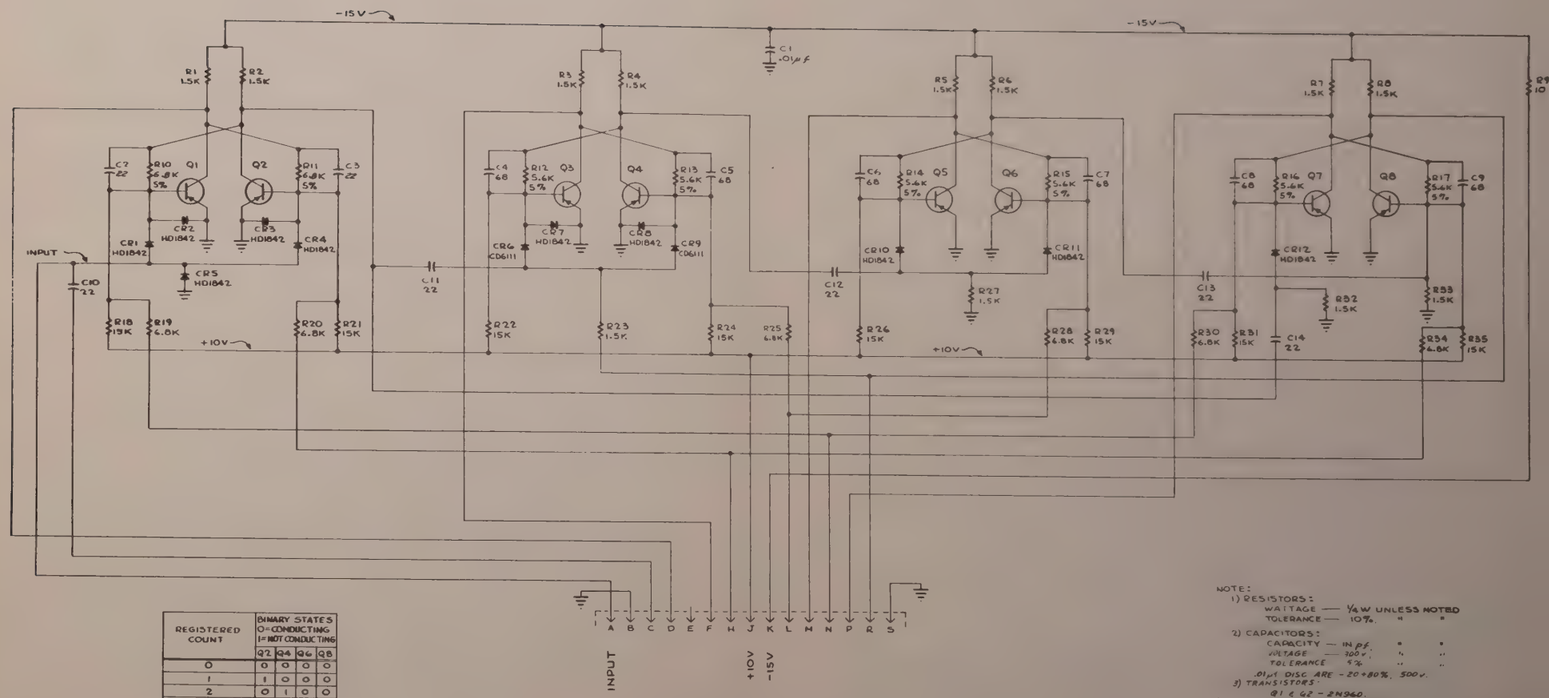
PARTS LIST

Detail No.	Beckman Part No.	Description	Typical Manufacturer & No.	Qty./ Assy.
C1	633-804717	Capacitor, F.Cerm., .01μf, 500V	Sprague 29C9B5	1
C2*	637-824014	Capacitor, F.Mica, 68pf, 300V, 5%	Arco DM16E680J-300	8
C3 thru C9		Same as C2		
C10*	637-824008	Capacitor, F.Mica, 22pf, 300V	Arco DM16C220J-300	5
C11 thru C14		Same as C10		
CR1	755-420893	Diode, Germ., Type HD1842	Hughes	10
CR2 thru CR5		Same as CR1		
CR6	755-815561	Diode, Silicon, 75PIV, 10ma	Continenta CD6111	2
CR7 & CR8		Same as CR1		
CR9		Same as CR6		
CR10*		Same as CR1		
CR11 & CR12		Same as CR1		
Q1	755-824880	Transistor, Germ., PNP, 150mw	Motorola 2N960	2
Q2		Same as Q1		
Q3	755-817587	Transistor, Germ., PNP, 150mw	Motorola 2N968	6
Q4 thru Q8		Same as Q3		
R1	601-823112	Resistor, F.Comp., 1.5K, 1/4W, 10%	Allen Bradley CB1521	12
R2 thru R8		Same as R1		

For Rev.B: C2 and C10 thru C14 are 637-824008, Capacitor, F.Mica, 22pf, 300V, 5%

Detail No.	Beckman Part No.	Description	Typical Manufacturer & No.	Qty./ Assy.
R9	601-823917	Resistor, F. Comp., 10Ω, 1/4W, 10%	Allen Bradley CB1001	1
R10	601-823397	Resistor, F. Comp., 5.6K, 1/4W, 5%	Allen Bradley CB5625	8
R11 thru R17		Same as R10		
R18	601-823107	Resistor, F. Comp., 15K, 1/4W, 10%	Allen Bradley CB1531	8
R19	601-823945	Resistor, F. Comp., 6.8K, 1/4W, 10%	Allen Bradley CB6821	6
R20		Same as R19		
R21 & R22		Same as R18		
R23		Same as R1		
R24		Same as R18		
R25		Same as R19		
R26		Same as R18		
R27		Same as R1		
R28		Same as R19		
R29		Same as R18		
R30		Same as R19		
R31		Same as R18		
R32 & R33		Same as R1		
R34		Same as R19		
R35		Same as R18		
	864-412958	Transistor Pad	Beckman	8

MODEL 860 DCU
SCHEMATIC DIAGRAM



REGISTERED COUNT	BINARY STATES 0=CONDUCTING 1=NOT CONDUCTING			
	Q2	Q4	Q6	Q8
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

NOTE:
1) RESISTORS:
WATTAGE — ¼ W UNLESS NOTED
TOLERANCE — 10% " "
2) CAPACITORS:
CAPACITY — IN pf. " "
VOLTAGE — 300 v. " "
TOLERANCE ± % " "
.01μf DISC ARE -20+80%, 500v.
3) TRANSISTORS:
Q1 & Q2 - 2N960.
Q3 THRU Q8 - 2N968.

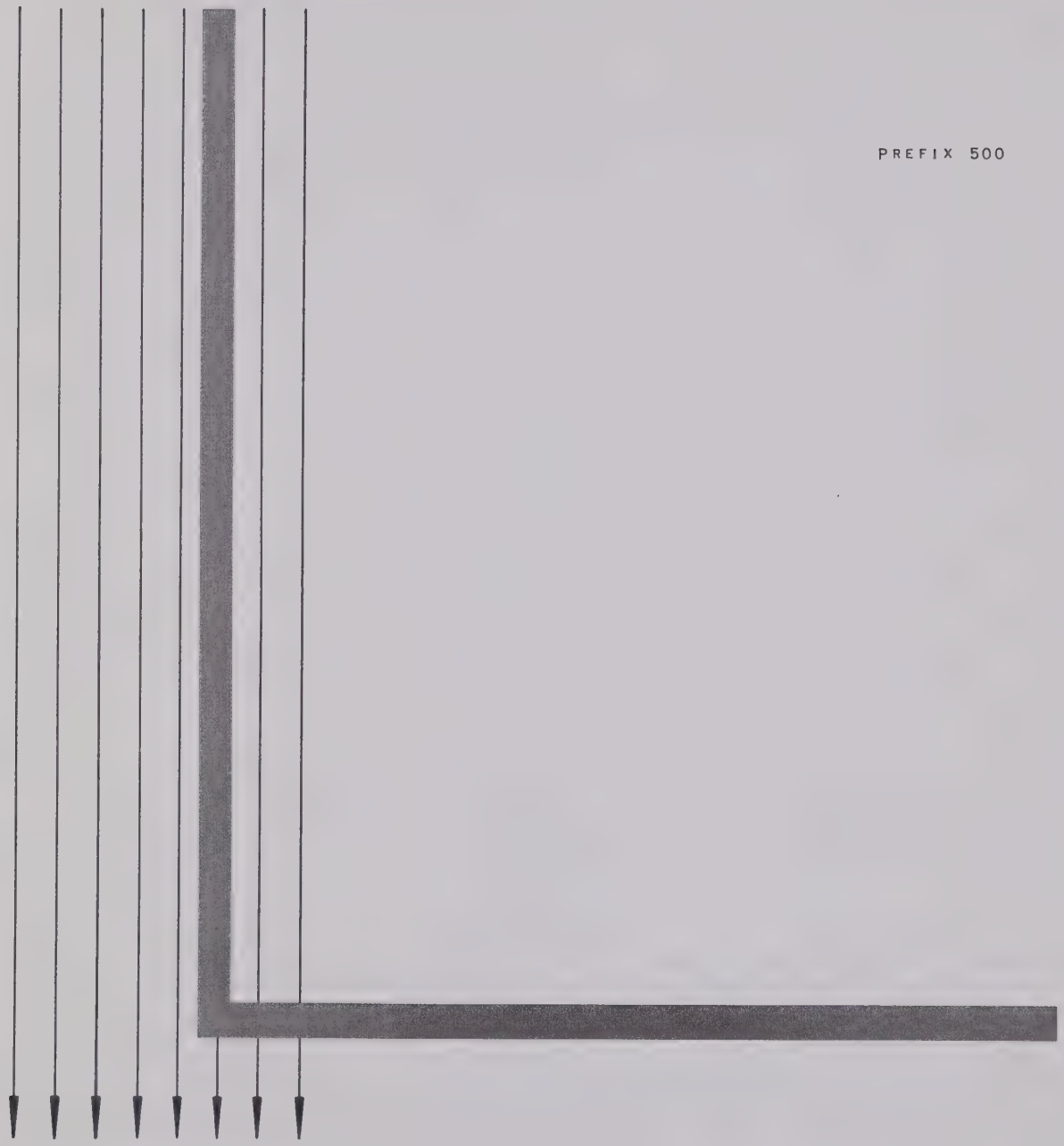
Model 860 DCU
D611532-Rev. B
January 1963

Beckman®

INSTRUCTION MANUAL

DATA STORAGE UNIT
(S C R)

PREFIX 500



May 1967

Beckman® INSTRUMENTS, INC.
ELECTRONIC INSTRUMENTS DIVISION
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Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in possession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company nameplate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Electronic Instruments Division of Beckman Instruments, Inc., Richmond, California, 94804.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

The Company reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

Beckman® INSTRUMENTS, INC.
ELECTRONIC INSTRUMENTS DIVISION
RICHMOND, CALIFORNIA • 94804

INTERNATIONAL SUBSIDIARIES: Geneva; Munich; Glenrothes, Scotland; Tokyo; Paris; Capetown; London; Mexico City.

DATA STORAGE UNIT (SCR)

Change Figure 3-2, step ③ to read:

Ratio R46 and R47 is such that the base of Q7 is negative with respect to ground, making Q7 conduct.

Change Figure 3-2, step ④ to read:

Ratio R45 and R49 is such that the base of Q8 is positive with respect to ground, cutting off Q8.

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*Silicon Controlled Rectifier

SECTION 1
INTRODUCTION

1.1 GENERAL

The Data Storage Unit (DSU) stores binary coded information received from a decimal counting unit (DCU) such as Beckman Model 850, 880, or 870, and displays this information on a separate electroluminescent readout. Upon command, the DSU converts binary information into a decimal equivalent. The DSU comprises a plug-in printed circuit board using all solid-state components.

1.2 SPECIFICATIONS

Table 1-1. Main Characteristics

COUNT DISPLAY	In-line digit on Sylvania Series NU-50 Electroluminescent panel (separate from DSU)
DISPLAY CONTROL OUTPUTS	Segment off: 50 volts p-p (typical) Segment on: 750 volts p-p (typical)
INPUT REQUIREMENTS (from DCU)	Binary "1": -6 volts Binary "0": -0.3 volts
CLEAR PULSE	-10 volts, 5 μs duration
SET PULSE	-10 volts, 5 μs duration
POWER REQUIREMENTS	B+: +10 volts at 2 ma B-: -15 volts at 23 ma Display: 900 volts p-p, 500 Hz
DIMENSIONS	6.56 inches by 4.09 inches
WEIGHT	5.3 oz.
MOUNTING	Two 15-pin P. C. Board Connectors

SECTION 2
OPERATION

2.1 INSTALLING THE DSU

The DSU plugs into two 15-pin printed card connectors.

2.2 INPUT REQUIREMENTS

Table 1-1 summarizes the input requirements of the DSU.

2.3 OUTPUT CHARACTERISTICS

2.3.1 Display Control Output

For each decimal digit (0 through 9) registered, a decoder in the DSU generates a combination of on/off voltages to control segments of a Sylvania series NU-50 electroluminescent display. Typical voltages are 50 volts peak-to-peak to extinguish a segment, and 750 volts peak-to-peak to light a segment.

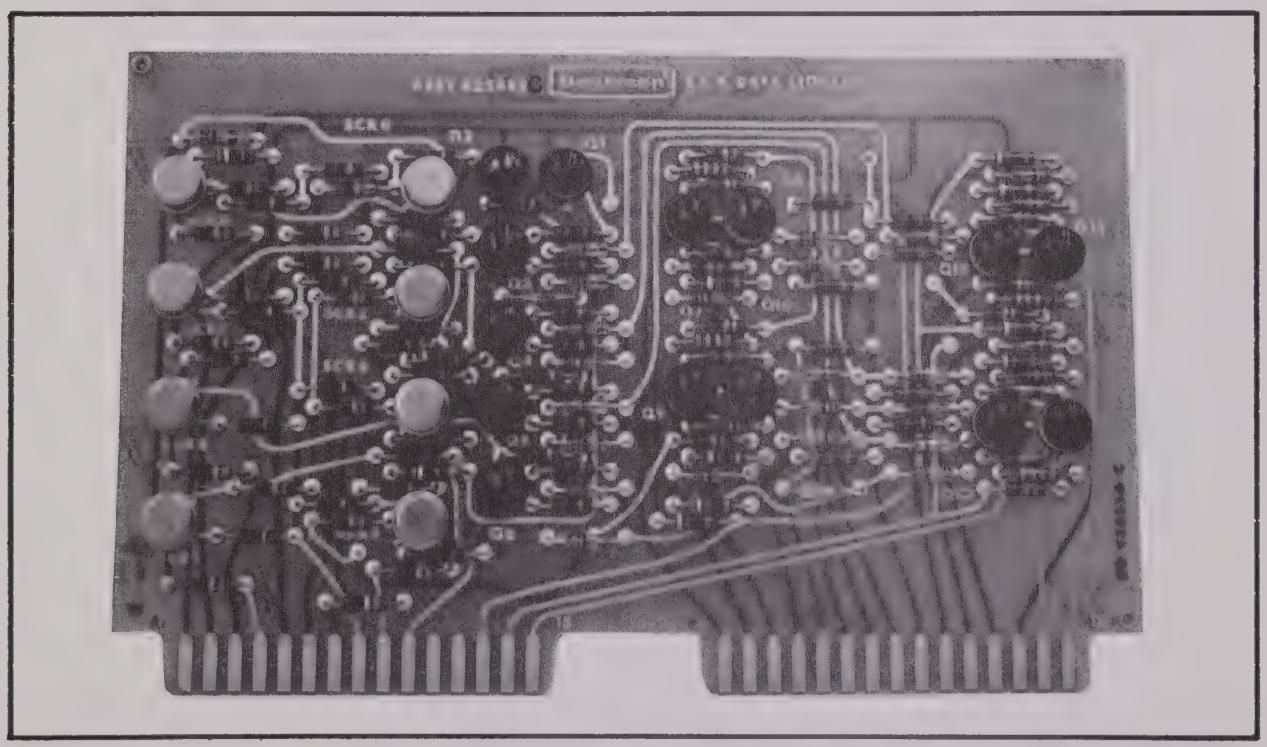


FIG. 2-1. SCR Data Storage Unit Plug-in Printed Circuit Board

SECTION 3
CIRCUITS

3.1 BASIC CIRCUITS

As shown in Figure 3-1, the DSU comprises a storage and decoding circuit with a separate digital display. Section 3.2 describes the storage circuit, a set of four binary (flip-flop) stages. Section 3.3 describes the SCR switching circuits.

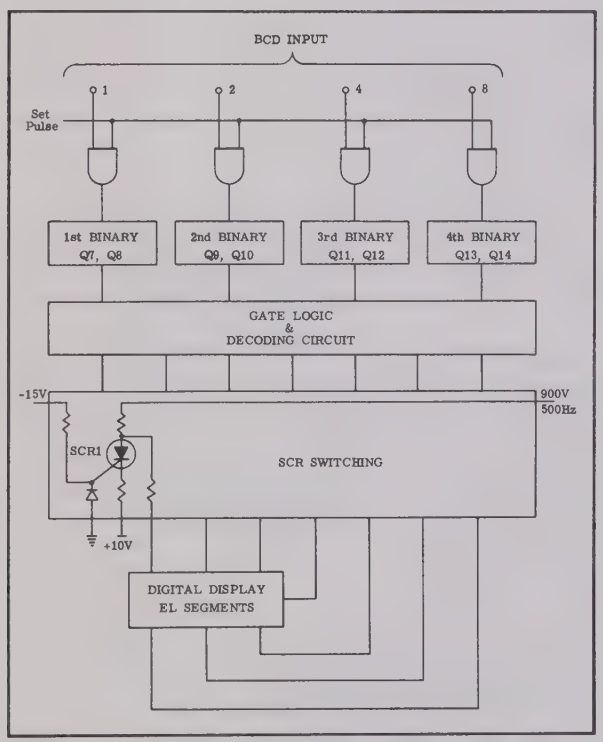


FIG. 3-1. Flow Diagram of Data Storage Unit

3.2 THE STORAGE CIRCUIT

Four binaries make up the storage circuit. Each binary comprises a pair of p-n-p transistors with the collector of each transistor directly coupled to the base of the other. Being symmetrical, the circuit can exist in either of two stable states: one transistor is cut off (OFF), and the other is conducting (ON).

In a p-n-p transistor, the input impedance is low (in the order of a thousand ohms) when the base potential is negative. This low input impedance permits a base current to flow and the transistor conducts. Conversely, a positive base potential results in a high input impedance (several hundred thousand ohms); therefore, no base current flows and the transistor is cut OFF.

Figure 3-2 shows a typical binary in the "0", or clear, state (Q7 ON, Q8 OFF) and explains how the circuit stabilizes itself in that state.

With a negative voltage applied to the input terminal and a negative set pulse to R51, the binary changes states by a process described in Figure 3-3. During the change, the collector voltage of one transistor drops sharply while the other rises. These collector voltage swings drive transistors Q1-Q6 to provide the logic needed in converting the stable states of the four binaries into seven lines of display control information.

Driven by the storage binaries, transistors Q1-Q6 control the SCR's. The ON-OFF combination of transistors Q1-Q6 provides the logic needed to control the electroluminescent segments.

3.3 SCR SWITCHING CIRCUITS

The SCR is a controlled switching device. Once it is switched to the ON state by a forward bias pulse, it can be turned off only by polarity reversal of the anode potential with respect to the cathode. An SCR can not be turned on unless both junctions are forward biased.

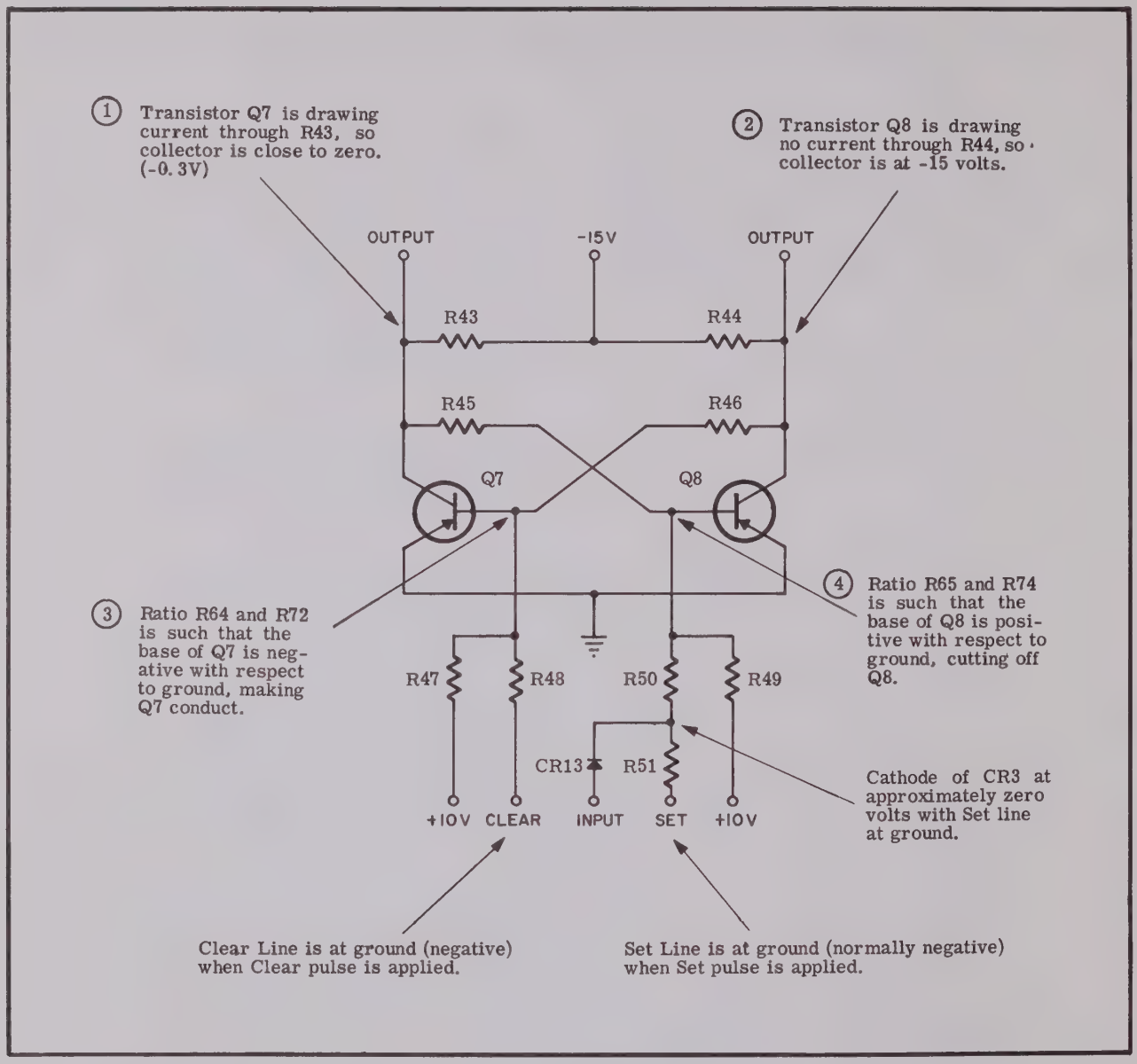

1 Transistor Q7 is drawing current through R43, so collector is close to zero. (-0.3V)
2 Transistor Q8 is drawing no current through R44, so collector is at -15 volts.
OUTPUT
-15V
OUTPUT
R43
R44
R45
R46
Q7
Q8
3 Ratio R64 and R72 is such that the base of Q7 is negative with respect to ground, making Q7 conduct.
4 Ratio R65 and R74 is such that the base of Q8 is positive with respect to ground, cutting off Q8.
R47
R48
R50
R49
CR13
R51
Cathode of CR3 at approximately zero volts with Set line at ground.
+10V
CLEAR
INPUT
SET
+10V
Clear Line is at ground (negative) when Clear pulse is applied.
Set Line is at ground (normally negative) when Set pulse is applied.

FIG. 3-2. A Typical Storage Binary in the "0" State

Referring to Figure 3-4:

1) The gate junction is forward biased when a positive pulse or level is applied to the gate.

2) For conduction, the anode must be at a higher positive level than the gate.

3) Once the SCR is turned on, its resistance and voltage drop are very low.

Figure 3-5 shows a simplified diagram of the logic used to control the EL segments. The outputs of the storage binaries (Q7-Q8, Q9-Q10, etc.) drive the gate logic and decoding circuits.

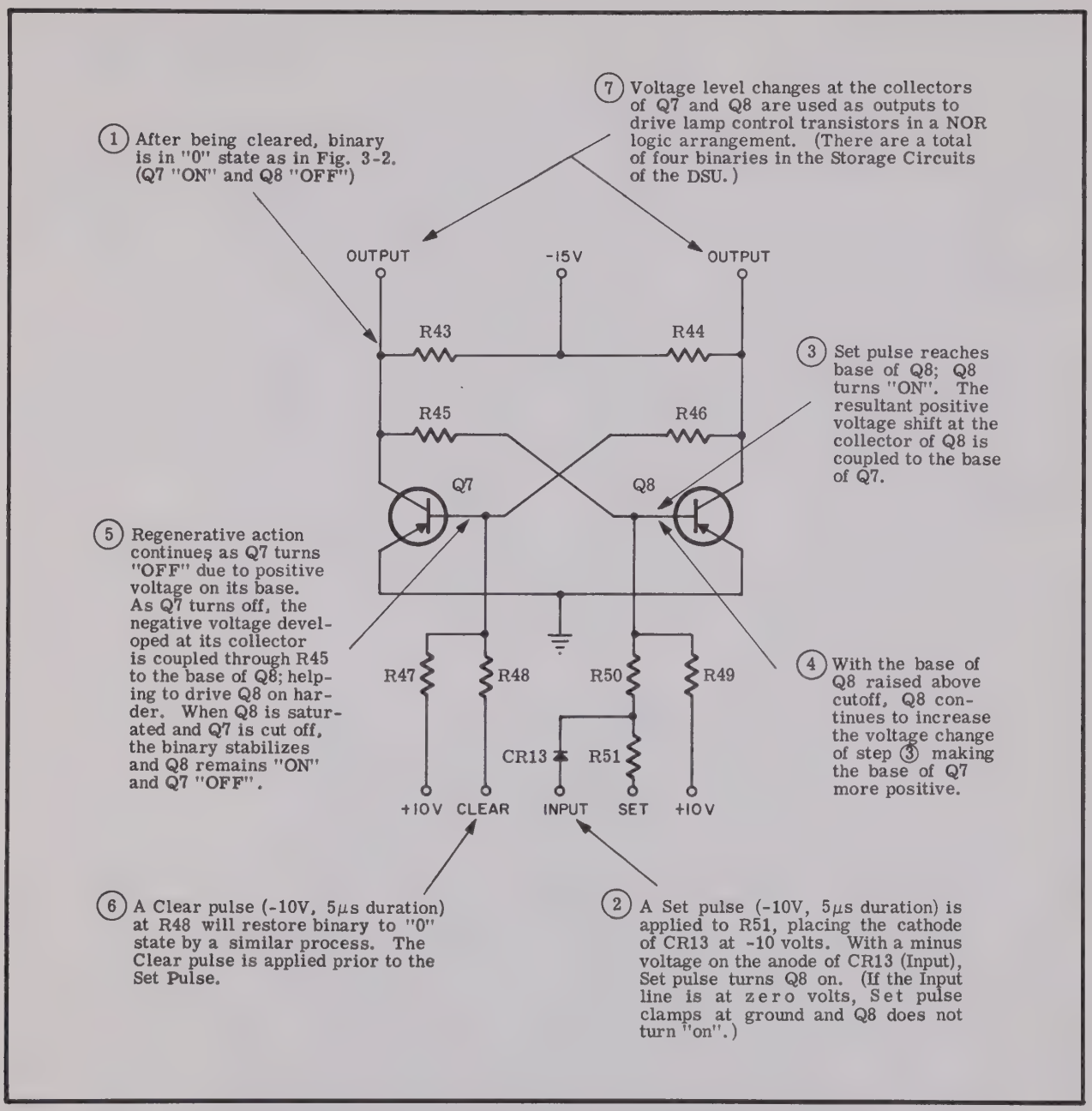

(7) Voltage level changes at the collectors of Q7 and Q8 are used as outputs to drive lamp control transistors in a NOR logic arrangement. (There are a total of four binaries in the Storage Circuits of the DSU.)
(1) After being cleared, binary is in "0" state as in Fig. 3-2. (Q7 "ON" and Q8 "OFF")
OUTPUT
-15V
OUTPUT
R43
R44
R45
R46
Q7
Q8
(3) Set pulse reaches base of Q8; Q8 turns "ON". The resultant positive voltage shift at the collector of Q8 is coupled to the base of Q7.
(5) Regenerative action continues as Q7 turns "OFF" due to positive voltage on its base. As Q7 turns off, the negative voltage developed at its collector is coupled through R45 to the base of Q8; helping to drive Q8 on harder. When Q8 is saturated and Q7 is cut off, the binary stabilizes and Q8 remains "ON" and Q7 "OFF".
R47
R48
R50
R49
CR13
R51
(4) With the base of Q8 raised above cutoff, Q8 continues to increase the voltage change of step (3) making the base of Q7 more positive.
+10V
CLEAR
INPUT
SET
+10V
(6) A Clear pulse (-10V, 5μs duration) at R48 will restore binary to "0" state by a similar process. The Clear pulse is applied prior to the Set Pulse.
(2) A Set pulse (-10V, 5μs duration) is applied to R51, placing the cathode of CR13 at -10 volts. With a minus voltage on the anode of CR13 (Input), Set pulse turns Q8 on. (If the Input line is at zero volts, Set pulse clamps at ground and Q8 does not turn "on".)

FIG. 3-3. Stages in the Transition of a Binary From the "0" State to the "1" State

Segment E is used to form the readout numbers 2, 6, and 8, and SCR1 should be OFF when these numbers are formed. SCR1 gate is biased to approximately -0.7 volts by divider R30 and CR2; the cathode is returned to the +10 volt supply by resistor R2. Ignoring the effect of OR gate R32-R33 in this condition, SCR1 gate junction is reverse biased and, therefore, in the OFF state.

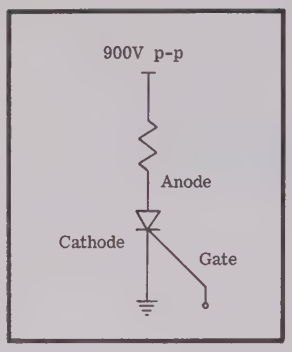


FIG. 3-4.

SCR Representation

1) $\overline{1}$ input is the opposite polarity of DCU output for binary state "1" (negative for all odd numbers).

2) $\overline{\overline{1}\ \overline{2}\ 4}$ is negative only when Q9 and Q12 collectors are negative and CR10 is back-biased; and Q1 emitter is negative (negative for all even numbers) and turns Q5 to the ON state.

Transistors Q1 and Q2 form an odd-even driver. That is, Q1 emitter is negative (approximately -10 volts) for all even numbers and Q2 emitter is negative (approximately -10 volts) for all odd numbers. R32-R33 OR gate has the following two inputs:

OR gate R32-R33 has a negative output as long as one of its inputs is negative (negative level overcomes positive). This negative level forward-biases SCR1 when the SCR is turned to the ON state. It reduces the voltage across EL segment E and turns it OFF.

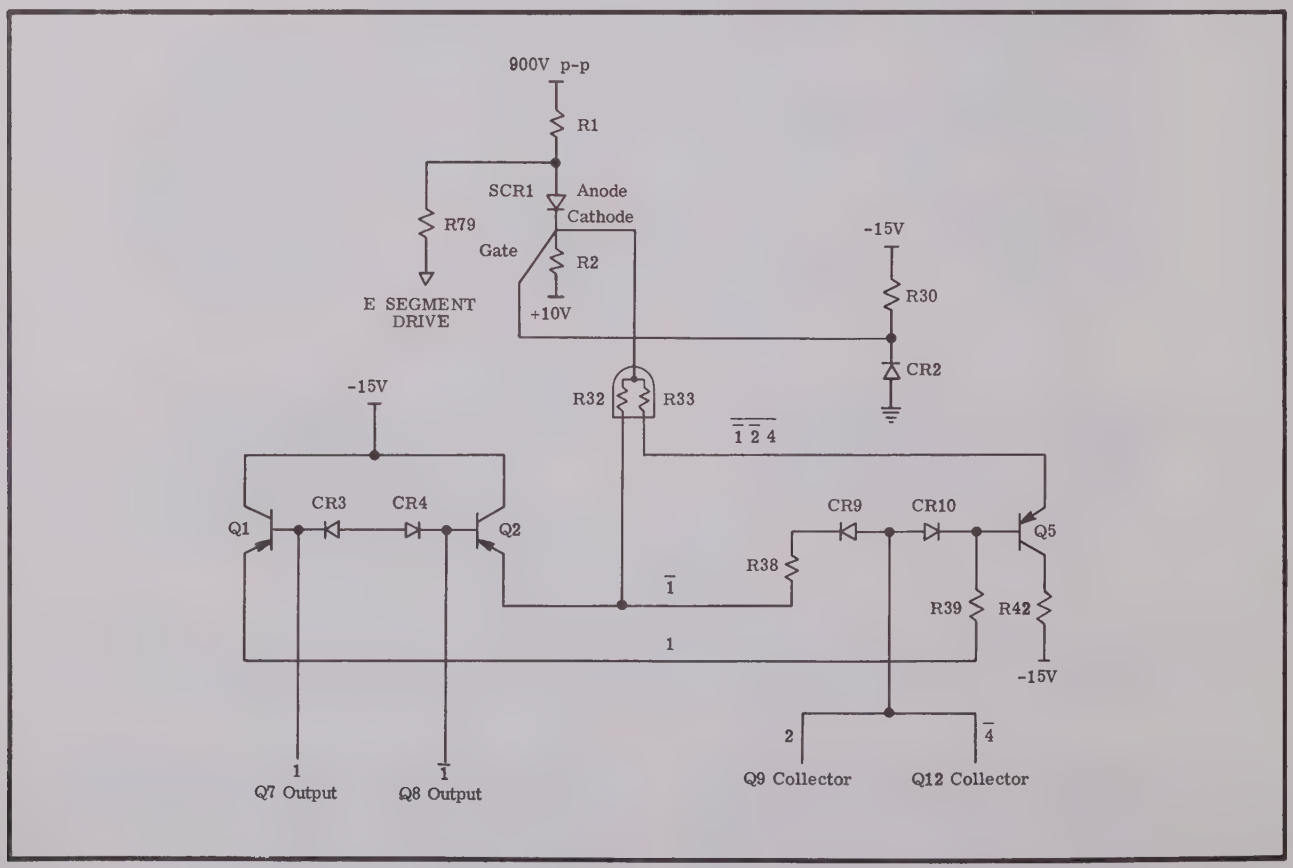
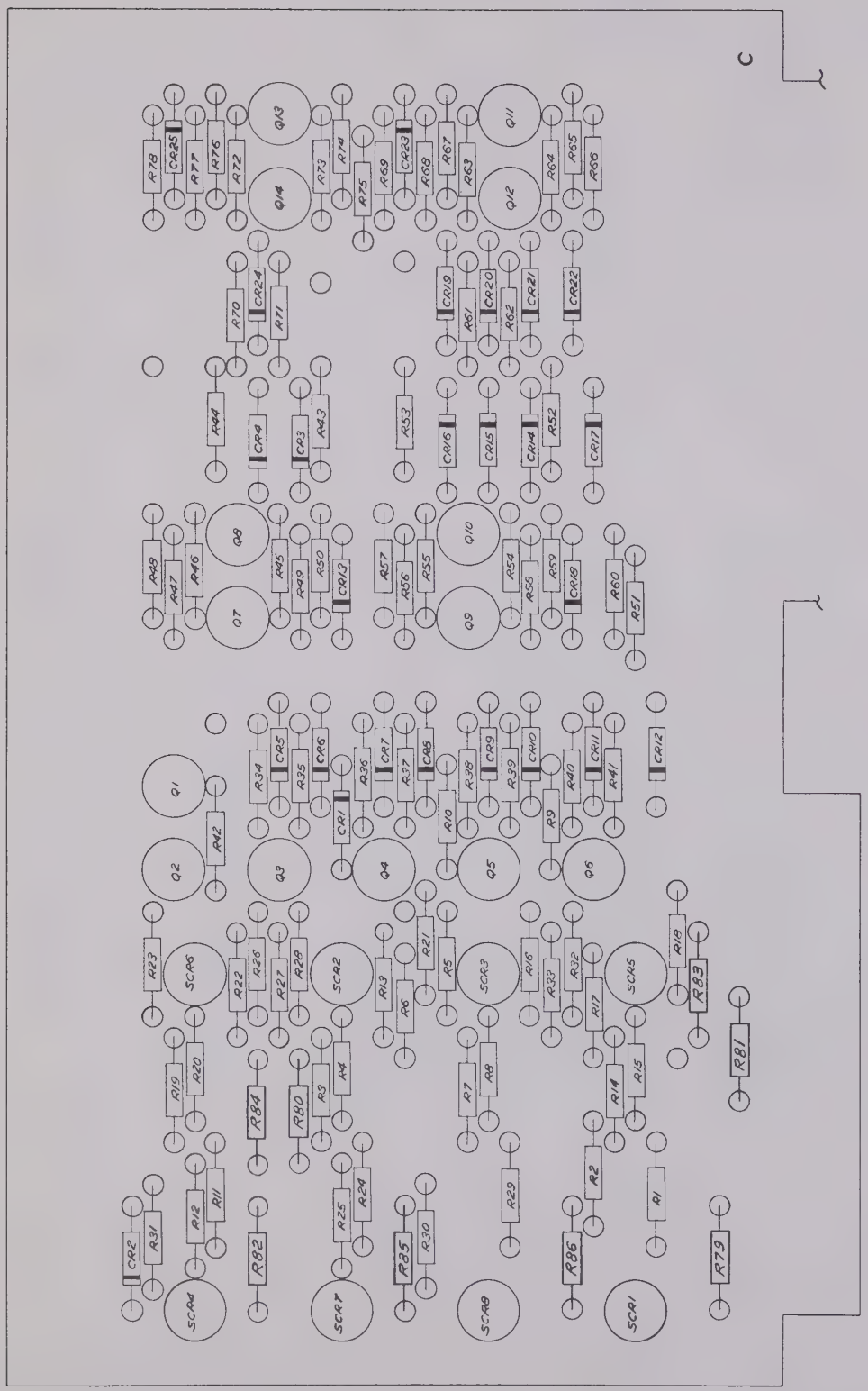


FIG. 3-5. Simplified Diagram of Logic to Control EL Segments



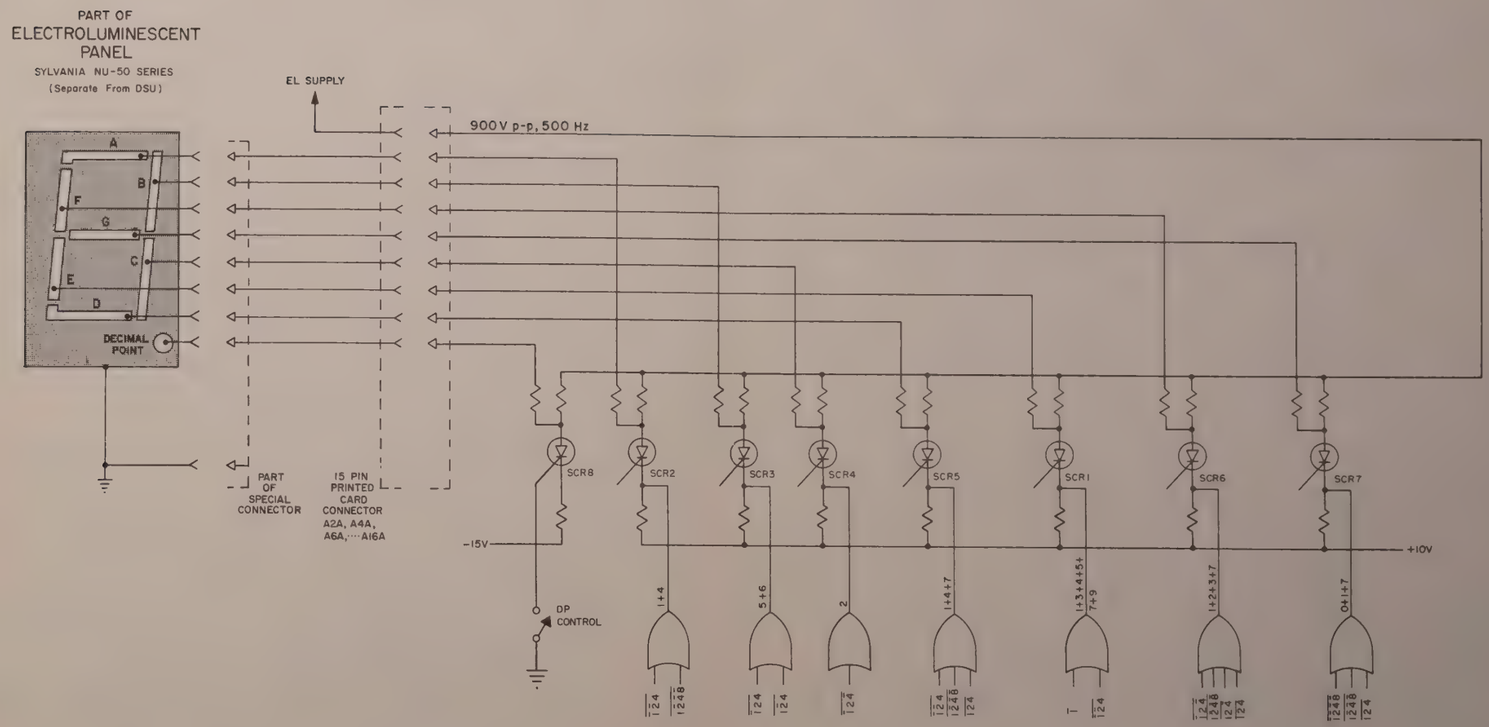
SCR Data Storage Unit Component Layout

PARTS LIST

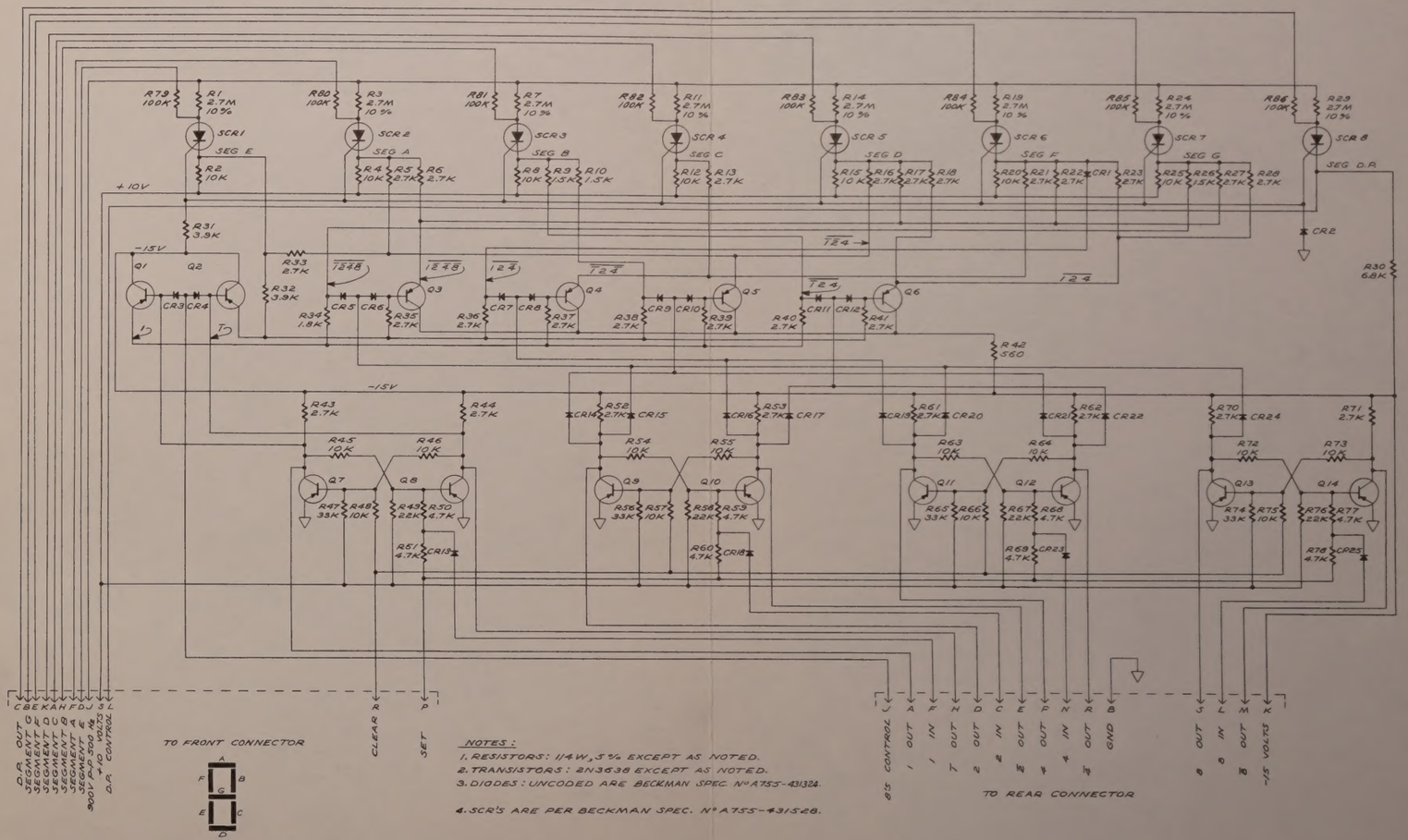
SCR DATA STORAGE UNIT

Detail No.	Beckman Stock No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
CR1 thru CR25	755-431324	Diode, Special	Beckman	25
Q1 thru Q14	755-838105	Transistor, Type 2N3638	Fairchild	14
R1, 3, 7, 11, 14, 19, 24, 29	601-824112	Resistor, F. Comp., 2.7M, 1/4W, 10%	Allen Bradley CB2751	8
R2, 4, 8, 12, 15, 20, 25, 45, 46, 48, 54, 55, 57, 63, 64, 66, 72, 73, 75	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	19
R5, 6, 13, 16, 17, 18, 21, 22, 23, 27, 28, 33, 35, 36, 37, 38, 39, 40, 41, 43, 44, 52, 53, 61, 62, 70, 71	601-822295	Resistor, F. Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	27
R9, 10, 26	601-822527	Resistor, F. Comp., 1.5K, 1/4W, 5%	Allen Bradley CB1525	3
R30	601-822299	Resistor, F. Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	1
R31, 32	601-822460	Resistor, F. Comp., 3.9K, 1/4W, 5%	Allen Bradley CB3925	2
R34	601-822544	Resistor, F. Comp., 1.8K, 1/4W, 5%	Allen Bradley CB1825	1
R42	601-823396	Resistor, F. Comp., 560Ω, 1/4W, 5%	Allen Bradley CB5615	1
R47, 56, 65, 74	601-822531	Resistor, F. Comp., 33K, 1/4W, 5%	Allen Bradley CB3335	4
R49, 58, 67, 76	601-822334	Resistor, F. Comp., 22K, 1/4W, 5%	Allen Bradley CB2235	4
R50, 51, 59, 60, 68, 69, 77, 78	601-822297	Resistor, F. Comp., 4.7K, 1/4W, 5%	Allen Bradley CB4725	8
R79, 80, 81, 82, 83, 84, 85, 86	601-823904	Resistor, F. Comp., 100K, 1/4W, 5%	Allen Bradley CB1045	8
SCR1 thru SCR8	755-431528	Silicon Controlled Rectifier	Beckman	8
	864-412958	Transistor Pad	Beckman	22

DECODER LOGIC DIAGRAM



SCHEMATIC DIAGRAM



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